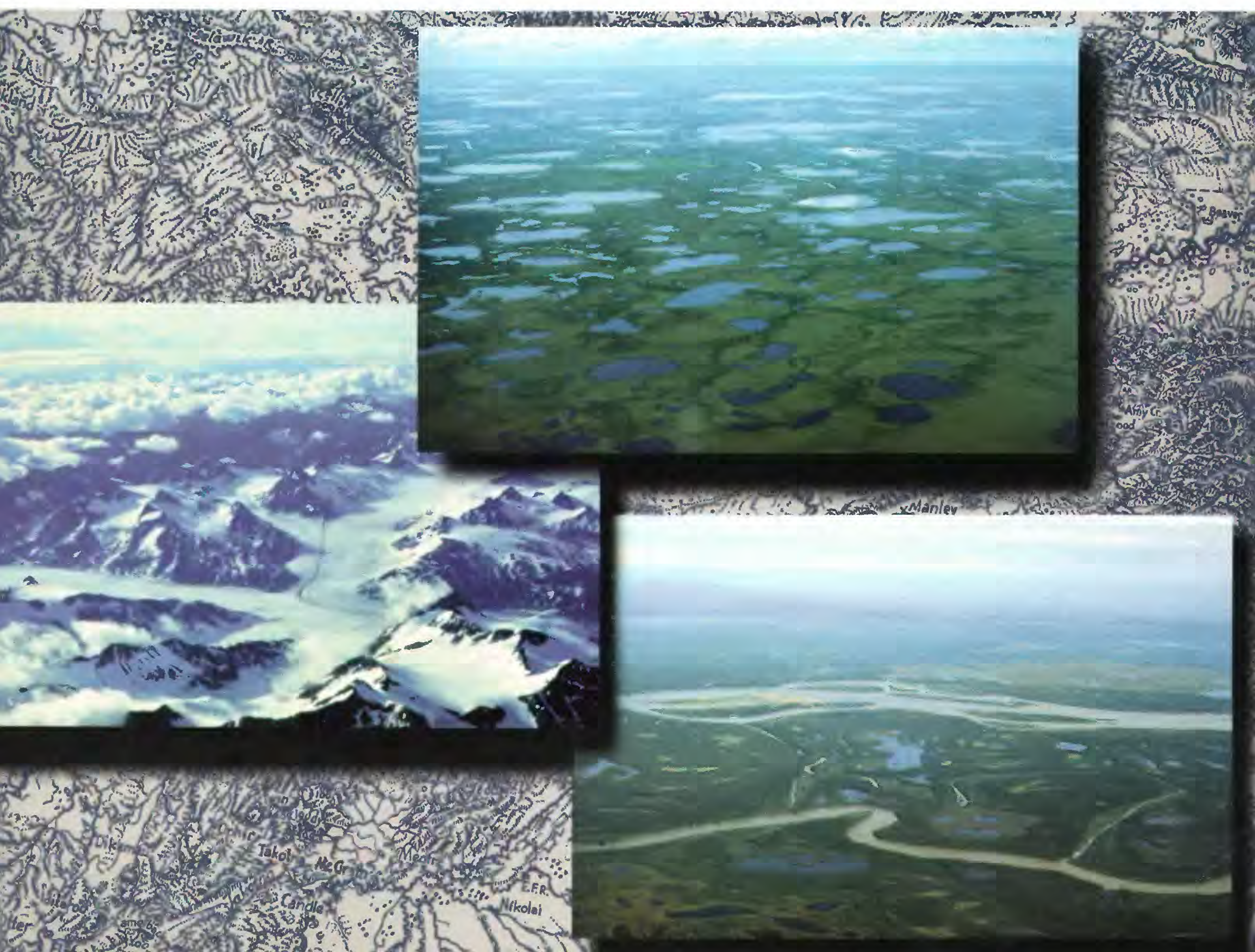
Ecoregions of Alaska

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1567

Prepared in cooperation with Colorado State University and the Environmental Protection Agency



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By Alisa L. Gallant, Emily F. Binnian, James M. Omernik, *and* Mark B. Shasby

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A spatial analysis of regional
ecological patterns in Alaska
using analog and digital maps
and descriptive information

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ECOREGIONS OF ALASKA

By Alisa L. Gallant[1], Emily F. Binnian[2], James M. Omernik[3], and Mark B. Shasby[4]

ABSTRACT

A map of ecoregions of Alaska has been produced as a framework for organizing and interpreting environmental data for State, national, and international inventory, monitoring, and research efforts. The map and descriptions of 20 ecological regions were derived by synthesizing information on the geographic distribution of environmental factors such as climate, terrain (including information on physiography, geology, glaciation, permafrost, and hydrologic features), soils, and vegetation. A qualitative assessment was used to interpret the distributional patterns and relative importance of these factors for influencing the character of the landscape from place to place. The specific procedures and materials used to delineate the ecoregion boundaries are documented, and the environmental characteristics in each ecoregion are described. An accompanying map shows the distribution of the ecoregions and the transitional areas along their boundaries.

INTRODUCTION

A map and descriptions of ecological regions (ecoregions) of Alaska have been produced as a framework for organizing and interpreting environmental data for State, national, and international inventory, monitoring, and research efforts. Ecoregions have been defined by Wiken (1986) as ecologically distinct areas resulting from "... the mesh and interplay of the geologic, landform, soil, vegetative, climatic, wildlife, water and human factors which may be present. The dominance of any one or a number of these factors varies with the given ecological land unit." The map of Alaskan ecoregions was derived by synthesizing information on the geographic distribution of environmental factors such as climate, terrain (including information on physiography, geology, glaciation, permafrost, and hydrologic features), soils, and vegetation. This synthesis was a qualitative assessment of the distributional patterns and relative importance of these factors for influencing the character of the landscape from place to place.

The ecoregion map has been designed to accommodate a wide range of regional concerns, basically any that affect, or are affected by, the environmental factors analyzed to develop the map. Examples of applications for the map include the assessment of natural resources (regional chemical, physical, and biological characteristics of surface waters, soil erosion potential, wildlife habitat diversity, and ecological risk assessment) and effects research (potential regional ecological effects from environmental contaminants or climate change). The map can also be used to evaluate how well research sites are distributed across ecoregions or along regional environmental gradients, and the regional descriptions can be used to infer the relative density of sample sites needed to represent the ecological variability occurring within each ecoregion so that site–level information can be extrapolated to larger areas. Given national trends toward more holistic monitoring and management of ecosystems, the ecoregion map and descriptions provide an ecological framework[5] to help integrate efforts among different environmental disciplines and agencies.

Sections in this report describe the origin of the need and philosophy for delineating ecoregions of Alaska (Background), general procedures (Methods) and references (Materials) used, and environmental characteristics occurring in each ecoregion (Ecoregion Descriptions). The accompanying map (pl. 1) shows the distribution of Alaskan ecoregions. Environmental characteristics that typify each ecoregion are tabulated in appendix 1 and also appear on the reverse side of the map. Specific methods used to delineate each ecoregion are discussed in the descriptions of the individual regions.

BACKGROUND

Interest in developing the map of Alaskan ecoregions evolved from the need to have an ecological framework that is based on a variety of environmental characteristics of interest to different State, Federal, and international agencies. Single–theme frameworks have traditionally been popular because they are customized for specific concerns, such as forest resources, soil characteristics, or agricultural potential. However, use of different frameworks by different administrative agencies results in duplication of effort and inability to integrate and co–reference data across agencies and disciplines (Rubec, 1979). An ecological framework

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[5]The term "framework" will be used throughout this report to represent the ecoregion map and accompanying descriptions as a package. The descriptions are an important component because they allow the user to assess the characteristics that are representative of each ecoregion and the relative amounts of within–region environmental variability. Use of the map without the descriptions restricts the selection of representative field sites for regional analyses.

that can integrate many environmental characteristics diminishes these problems and assists in the exchange of information (Bailey and others, 1985). The utility of multipurpose ecoregion frameworks, such as those developed for the conterminous United States (Omernik, 1987, 1995) and Canada (Wiken, 1986), has been successfully demonstrated in various projects (for example, Hughes and others, 1986; Rubec, 1979; Whittier and others, 1988; Whittier and others, 1987). Work is under way to combine the frameworks for Canada and the conterminous United States into one covering all of North America (James Omernik and Ed Wiken, oral commun., 1993, 1994). Delineation of Alaskan ecoregions is a step to furthering this work. Additionally, a growing interest in the effects of potential global environmental change on ecosystems, particularly on arctic systems,[6] has promoted an effort to expand the ecoregional frameworks developed for Alaska and Northern Canada to all the northern circumpolar area.

The ecological frameworks developed for Alaska, the conterminous United States, and Canada reflect a common philosophy and methodology, making it possible to combine these frameworks across international borders. The approach and objectives of these frameworks differ from those used to develop other, multipurpose[7], regional schemes covering Alaska, such as the "Land Resource Regions and Major Land Resource Areas of the United States" (commonly referred to as MLRA's; U.S. Soil Conservation Service, 1981), the "Major Ecosystems of Alaska" (Joint Federal-State Land Use Planning Commission for Alaska, 1973), and the "Ecoregions and Subregions of the United States" (Bailey and others, 1994).

The map of MLRA's depicts two levels of classification hierarchy that were developed by considering a number of environmental characteristics similar to those used to delineate the ecoregions of Alaska. However, the main focus of the Soil Conservation Service in developing MLRA's was land management concerns; the identification of regions was based on their land use potential. In addition, the Soil Conservation Service did not have access to several statewide references that have since become available. These references improve the data base for interpreting ecoregion patterns.

The map of "Major Ecosystems of Alaska" (Joint Federal-State Land Use Planning Commission for Alaska, 1973) shows the distribution of nine classes of ecosystems within a single hierarchic level. The focus of the ecosystems map is on the regional distribution of vegetation community type and structure. Information relating to other landscape characteristics, such as topography, hydrology, and climate, is considered only so far as it influences ecosystem type. The resultant classes contain much variability in environmental characteristics that are not reflected in the ecosystem type. For example, the "Alpine Tundra" ecosystem class encompasses mountain formations of different geologic origin and climatic regime. Therefore, the map may not be useful for addressing concerns related to soil or surface water characteristics.

The map "Ecoregions and Subregions of the United States" (Bailey and others, 1994) depicts four hierarchic levels of terrestrial ecological units. The authors explain that, "At each successive level [of the hierarchy] a different ecosystem component is assigned prime importance in the placing of map boundaries." Climatic characteristics are used to delineate regions at the broadest level; vegetative features are used at the second level; the distinction between montane and nonmontane areas distinguishes the third level; and physiographic units define the finest level.

The "Ecoregions of Alaska" map depicts a single level of resolution (although the ecoregions are being aggregated to conform with the coarser level of resolution planned for the map of North American ecoregions that was discussed earlier). Unlike the method used by Bailey and others (1994) in defining the ecoregions for Alaska, our approach is to consider a suite of environmental characteristics, regardless of the level of hierarchic resolution, rather than assigning importance to a single environmental characteristic per level of classification hierarchy.[8] There are at least three reasons for this approach. First, the degree of influence of any one environmental characteristic changes from region to region, and even within regions (Omernik, 1987, 1995; Wiken, 1986); that is, there is no single, consistently reliable predictor of where boundaries should be drawn for multipurpose regions. An example is the popular use of "climate" at global, regional, and finer scales to predict the distribution of ecosystems. The predictions have been disappointing in light of the actual distribution of ecosystems. The reason for this poor performance is that vegetation is also strongly affected by other characteristics, such as interspecific competition, factors affecting soil temperature and moisture, rate of seed dispersal and establishment of propagules, and land management practices (Barbour and others, 1987; Davis and others, 1986 in Prentice, 1992; Prentice, 1992;), so consideration of interrelationships among several environmental

[6]This interest is evidenced in the escalating number of international meetings and symposia on arctic ecological concerns, such as those included in this list of recent meetings: (1) The Panarctic Biota Project (Moscow, Russia, February 1991), (2) the Arctic Monitoring and Assessment Program (TromsØ, Norway, December 1991), (3) the Classification of Circumpolar Arctic Vegetation (Boulder, Colorado, USA, March 1992), (4) the Second Circumpolar Symposium on Remote Sensing (TromsØ, Norway, May 1992), (5) Global Change and Arctic Terrestrial Ecosystems Conference (Oppdal, Norway, August 1993), (6) the Arctic Environmental Reference Database Workshop (Arendal, Norway, September 1993), (7) the International Symposium on the Ecological Effects of Arctic Airborne Contaminants (Reykjavik, Iceland, October 1993), and (8) the Third Circumpolar Symposium on Remote Sensing of Arctic Environments (Fairbanks, Alaska, USA, May 1994).

[7]The term "multipurpose" refers to regions that reflect general patterns of many ecosystem characteristics, therefore providing an ecological framework that should be generally useful for many environmental purposes.

[8]The ecoregional maps delineated for the conterminous United States (Omernik, 1987) and Canada (Wiken, 1986) were developed using this approach.

variables is necessary to understand distributional patterns.

Second, if emphasis is placed on a single factor at a particular hierarchic level, the resultant regions may not reflect the distribution of other important features that have only a weak association with that factor. Recall that in the example described for the map of "Major Ecosystems of Alaska," regional patterns related to soil type or surface water characteristics were not adequately recognized when the single factor of vegetation community type was emphasized for delineating the regions.

Third, the data set representing the distribution of the single factor includes varying degrees of informational resolution and accuracy. For example, weather stations are not distributed in a systematic network. The quality of interpolation of data among stations is affected by the methods of measurement at each station, the distance between stations, and the intervening orographic (or other) effects. Similar problems arise with soil or geology references, where continuous map surfaces have been generated from differentially distributed observations. Therefore, weaknesses in a single information source can have a heavy impact when that source is emphasized in delineating regions. Incorporating a suite of independently derived references into the delineation process helps to counter the influence of weak information from a single data source.

The multihierarchic maps so far discussed (the MLRA's and "Ecoregions and Subregions of the United States") primarily represent a "top down" approach toward delineating ecological units. Information is first analyzed to delineate the coarsest level of classification in a hierarchy (on the order of 10^4 km^2 for our purposes). Successively more detailed information is then analyzed to subdivide the classes into more detailed subunits. An alternate approach is described by Walker and Walker (1991) in their work on Alaska's North Slope. Data are gathered and patterns analyzed beginning at the microscale level (10^0–10^6 m^2). A hierarchy of units is then constructed upward ("bottom up") through mesoscale (10^2–10^4 km^2) and macroscale (10^4–10^6 km^2) levels of information. The objectives of the approach taken by Walker and Walker (1991) were to define the types of ecological processes, questions, data, and linkages appropriate to different hierarchic scales of regional analysis. Such an approach requires a very long–term, intensive effort for mapping regions. Since our objective was to develop an ecoregion framework for the state of Alaska, a "top down" approach was more appropriate because it directly addressed the landscape scale of interest, with little dependence on intensive, detailed ecosystem studies. This top–down approach not only resulted in a product within a relatively short time, but also provided an overall ecological context for further subdivision of regions as interest and availability of more specific data emerge.

When ecoregions are being mapped, errors can be introduced into the process in several ways. Boundaries and other map components may be inaccurately located; classes can be incorrectly assigned or may not be informationally discrete; the spatial or informational resolution of classes may be misrepresented; data may not be available for some areas; and data accuracy may change because of temporal aspects in the landscape (for example, water level changes). These factors pertain to the reference maps used to derive the ecoregion map, as well as to the process used to delineate the ecoregions. This makes it difficult to determine the accuracy of the map.

Other problems with determining the accuracy of an ecoregion map relate to field sampling logistics, within–region heterogeneity, and field and map differences in informational resolution.

Field Sampling Logistics. – Because each ecoregion has been defined on the basis of a number of ecological characteristics, field verification of the ecoregion map would entail collecting information on climate, physiography, geology, soils, permafrost, glaciation, hydrology, and vegetation for each sample site. Some of these variables are readily evaluated in the field, but others are not. The difficulty of collecting information for all of these variables at each site, plus the problem of site accessibility (most sites are not accessible by ground transportation, and many are not accessible by air), makes accuracy assessment from the field infeasible.

Within–Region Heterogeneity. – The array of combinations of environmental characteristics that could be expected within each ecoregion would have to be represented in the field verification data set. This requires a more detailed level of within–region analysis than that used to delineate the ecoregions because of the top–down approach that was used.

Field and Map Informational Resolution. – The ecoregions have been delineated at a very general level of informational resolution. It would be necessary to design the collection of field data so that the same level of generalization is represented. This is difficult because the surrounding environmental context for an ecoregion may be lost at the site level.

Because of the multipurpose nature of the ecoregion map, it may be inappropriate to attempt to assess its accuracy. Boundaries between regions are expected to be "generally" correct for a number of purposes, but are not expected to precisely fit the distribution of any singular variable. Therefore, there is not even a conceptual set of boundaries that will be perfect for all uses of the map. It is more pertinent to assess whether stratification of sample data by ecoregion helps to explain spatial variation of particular variables of interest (an assessment of the utility of the map).

METHODS

A number of environmental references were examined for this analysis, including statewide information on climate (seasonal and annual temperatures, rain, and snow), physiography (landsurface forms, topography, elevation, amount of local relief, and local surface irregularity), surficial and bedrock geology, soils, permafrost, glaciation, hydrology, and current and potential vegetation. Previous work (Gallant and others, 1989; Omernik, 1987; Oswald and Senyk, 1977; U.S. Soil Conservation Service, 1981; Wiken, 1979, 1986) has shown that these factors are of primary importance for delineating ecoregional patterns. The steps for mapping ecoregions have been described in Gallant and others (1989) and involve delineating areas where unique combinations of different environmental factors coincide. In Alaska, for example, topographic data and physiographic maps show several extensive flat coastal plain areas that coincide with areas depicted as wet tundra on a map of major ecosystems. Among these coincidental areas, one occurs where arctic climate prevails, while several occur where subarctic climate prevails. Different climatic regimes result in different growing season lengths, different hydrologic cycles, and some variation in occurrence of plant species. Such differences led us to distinguish the Arctic Coastal Plain Ecoregion from the Subarctic Coastal Plains Ecoregion. Another example includes the montane areas in Alaska. All of these areas are mapped as having steep, high, rugged mountains and alpine tundra ecosystems. Within these areas of coinciding terrain and vegetation components are areas subject to arctic, continental, transitional, or coastal climatic influences that affect hydrologic characteristics and plant species distributions. Additionally, there are different geologic formations and soil parent materials that affect soil chemistry and moisture holding capacity and the physical and chemical characteristics of surface waters. These variations in conditions resulted in our recognition of several different montane ecoregions.

We used a predominantly qualitative approach for evaluating and delineating ecoregions. It would have been quicker and easier to duplicate a product derived from a strictly quantitative approach; however, we thought that the product would have been less accurate in its representation of ecoregions. It is difficult to apply strict quantitative weightings to represent the importance of different environmental factors for delineating ecoregions because the importance of these factors, and the accuracy with which they are mapped, vary within and among ecoregions. An example occurs within the Yukon–Kuskokwim lowland portion of the Subarctic Coastal Plains Ecoregion. The importance of a particular vegetation type for defining the extent of the ecoregion varies across the region. Areas north of the Yukon River include both wet and moist tundra communities and exclude forests, while areas south of the Yukon River include only wet tundra because moist tundra is more indicative of the adjacent region to the south. A qualitative, interactive approach allows the human interpreter to recognize the need for changing the delineation criteria along the border of adjacent ecoregions. A more mechanical approach would simply delineate the ecoregions using prescribed factor weightings. The question of whether a factor's importance varied throughout a region would most likely be overlooked.

The decision of when to delineate an area as an ecoregion is a judgment call that depends on (1) the combination and pattern of environmental characteristics occurring in that area versus those in the surrounding areas, (2) the size of the area, (3) the informational resolution and accuracy of the reference material used in delineating regions, and (4) the informational resolution and scale intended for the final framework. These four aspects are further described below.

1. There is more variation in the combination of environmental characteristics within some regions than between others. The size and distribution of the components that make up a landscape pattern are important for deciding whether areas should be classified as separate regions or consolidated within a single region at a given level of regional resolution. For example, the Ahklun and Kilbuck Mountains Ecoregion consists of clusters of steep, jagged peaks separated by broad valleys. At the informational resolution depicted on our map, it is more appropriate to aggregate these mountains and valleys into a single ecoregion. However, the ecoregion could then be subdivided to separate the mountains from the valleys at a finer level of resolution.

2. There are no hard and fast rules for designating a minimum–area criterion for ecoregions. Generally, 10,000 km^2 or larger is a good size for regions of State–level frameworks because the area is large enough both to be distinctive on statewide maps of environmental variables and to be recognized as a management unit for State resources. However, in some circumstances this "rule" is not suitable. For instance, an extensive ecoregion might have many small outliers that are easily distinguishable on the reference materials, as in the Interior Highlands and the Interior Bottomlands Ecoregions in Alaska. The outliers, alone, are too small to be considered as a separate ecoregion; but in the context of mapping the larger, more extensive part of the ecoregion, it makes sense to delineate associated outliers that are still discernible at the statewide scale. Another exception to a size criterion arises when an ecoregion is broken up by a waterbody, as in the Aleutian Island Ecoregion. All of the individual islands may be smaller than the minimum–size criterion, but they are distinctive enough to be recognized as a region in the context of their grouping and their location, and their total area exceeds the minimum–size criterion.

3. The informational resolution and accuracy of the reference materials used for delineating ecoregions impose implicit limits on the level of detail that can be depicted in the resultant ecoregion map. It is misleading to delineate regions that are more detailed than the bulk of the reference material from which they were defined; rather, regions should be less detailed than the components that were used to define them.

4. The intended use of the final framework affects the size and level of detail that is delineated for the regions. A very general framework will have relatively large regions separated by smooth boundaries. Accompanying regional descriptions will also be fairly general, listing only the major characteristics that typify each region. A very refined frame-

work will have small regions (or one or more levels of regional hierarchy) with more intricate boundaries and detailed descriptions of regional characteristics. The purpose for creating the framework governs the level of detail that should be shown on the final product.

The general procedures used to produce the map of ecoregions of Alaska involved an iterative cycle of steps. The initial delineation of ecoregions was based on analysis of hardcopy maps and descriptive text. Maps representing the environmental variables listed earlier were examined to locate concurrent spatial patterns of the different variables. Also considered were the ecological processes associated with these factors. An early draft map of ecoregions was prepared by outlining areas (that met the minimum size criterion) of unique combinations of factors. This initial draft map was used to plan an itinerary for summer field reconnaissance. The purpose of the reconnaissance was to compare ecosystems on the ground with the variables that represented them on the reference maps. Prospective ecoregions were visited by means of low–altitude flyovers and, where accessible, by ground. The draft map of ecoregions was then modified on the basis of field reconnaissance, and a second version was prepared and circulated to a number of regional experts for review. Reviewers were asked to comment, based on their field experience, on whether the set of ecoregions depicted on the map corresponded with their understanding and general knowledge of ecological patterns in Alaska. Review comments provided guidance toward modifications for a third draft map. This third map was circulated to the reviewers, and their comments were incorporated. Final boundary placement involved manipulating of digital files in a geographic information system (GIS) to reduce errors introduced by estimating the location of landscape patterns from the variety of scales and projections used in the reference maps. The GIS also was helpful for creating new maps derived by combining information from different reference maps (for example, mapping the coincidence of the distribution of major ecosystem types with different terrain features or with patterns on images developed from satellite data).

The final map of ecoregions was further augmented to show the approximate transitional zones between regions. The zones are depicted as cross–hatched areas overprinted on the ecoregions. A transitional zone represents an area that shares the characteristics of adjacent regions. For example, a transitional zone between a mountainous region and a plains region might consist of widely scattered mountains separated by broad plains. Within each ecoregion are areas that are not indicative of the environmental characteristics that typify the region. These areas are not shown as transitional zones. Transitional zones distinguish land that is adjacent to, and shares the characteristics of, two or more ecoregions. Because of the relatively small scales of the ecoregion map and the references used to develop the map, it is not possible to depict transitional zones along all of the ecoregion boundaries. It is important to remember that a line on the ecoregion map already represents an area (swath) on the ground, even when no additional transitional zones are indicated.

When selecting names for ecoregions, we generally tried to include information on the location of the region, as well as a dominant distinguishing feature. Some examples of names are: (1) Arctic Coastal Plain Ecoregion, which confers climatic, physiographic, and location information, (2) Interior Forested Lowlands and Uplands Ecoregion, which confers information on physiography, vegetation community structure, and location, and (3) Coastal Western Hemlock–Sitka Spruce Forests Ecoregion, which indicates maritime climate, forest type, and coastal location attributes. Most of the mountainous regions simply bear the name of their respective physiographic units, because this information conveys both location and terrain characteristics. Regions encompassing a large variety of ecological characteristics, such as the Seward Peninsula and Cook Inlet Ecoregions, have names that denote only location. Attempts to make the names more descriptive would have made them long and unwieldy. We also avoided locational adjectives that are Alaska–centered, such as northern or southeastern, because eventually Alaskan regions will be included in North American and Northern Circumpolar regional frameworks.

MATERIALS

Statewide and regional data sets and reports were acquired for climate, physiography, elevation, geology and geomorphology, soils, permafrost, glaciation, vegetation, hydrology, wildfire occurrence, land use, and wildlife characteristics. These references are itemized below by topic.

Climate. – Weather station data were obtained primarily from two sources: (1) the World WeatherDisc (WeatherDisc Associates, Inc., 1990, U.S. Monthly Normals and Worldwide Airfield Summaries data sets), a data base containing data acquired from the archives of the National Climatic Data Center and the National Center for Atmospheric Research and (2) a six–volume set of Regional Profiles of Alaska (Selkregg, 1974). Climatic information was also compiled from regional descriptions in several publications (Black, 1955; Hopkins, 1959; Kimmins and Wein, 1986; Oswald and Senyk, 1977; Reiger and others, 1979; Slaughter and Viereck, 1986).

Terrain. – A number of references provided information on physiographic characteristics (Black, 1955; Drury, 1956; Oswald and Senyk, 1977; Reiger and others, 1979; Spetzman, 1959; U.S. Geological Survey, 1964; Wahrhaftig, 1965). The U.S. Geological Survey (USGS) Map E shaded–relief map (1987a) was also useful. USGS digital elevation data at a 1–km^2 resolution were used to determine elevation, slope gradient, and terrain roughness. Terrain roughness is an evaluation of the variability of local (within 5 km) topographic relief. A terrain roughness map was derived using the steps identified in appendix 2. Classes of local terrain roughness include very low, low, moderate, high, and very high (see appendix 2 for a definition of these classes).

Information on geology was obtained from maps and reports by Beikman (1980), Black (1951, 1955, 1969), Drew and Tedrow (1962), Karlstrom and others (1964), Oswald and Senyk (1977), Reiger and others (1979), Selkregg (1974), Spetzman (1959), U.S. Geological Survey (1964, 1987a), and Wahrhaftig (1965).

A map showing the extent of Pleistocene glaciation in Alaska (Coulter and others, 1962) was the main source of information on glaciation. Several reports (Oswald and Senyk, 1977; Reiger and others, 1979; U.S. Geological Survey, 1964; Wahrhaftig, 1965) were also helpful.

Information on permafrost came from a map classifying the distribution of permafrost in Alaska (Ferrians, 1965). Other publications (Black, 1955; Ferrians and Hobson, 1973; Reiger and others, 1979) were used to augment this information.

Several publications were helpful for characterizing surface waters and other hydrologic features (Drury, 1956; Reiger and others, 1979; Selkregg, 1974; Wahrhaftig, 1965; U.S. Geological Survey, 1987a). A map showing the distribution of wetlands in Alaska (Hall, 1991) was helpful in depicting general areas of wetlands, but it included no further classification of wetland types.

Soils. – A series of draft maps of various soil components, derived from information published in the Exploratory Soil Survey of Alaska (Reiger and others, 1979), was provided by the USGS (Larson and Bliss, written commun., 1992). Several published references were also used (Drew and Tedrow, 1962; Reiger and others, 1979; Selkregg, 1974). More recent soil information (since the publication of the Exploratory Soil Survey) was provided by soil scientists (Moore, written commun., 1993 and Ping, written commun., 1993).

Vegetation. – No statewide vegetation map has been completed for Alaska, although parts of the State have been mapped by different agencies. A subset of these maps (Fitzpatrick–Lins and others, 1989; Markon, 1992; Powell and others, 1993; Talbot and Markon, 1986, 1988; Talbot and others, 1986; U.S. Geological Survey, 1987b), along with other descriptive information and species lists (Drury, 1956; Fleming, written communication, 1993; Reiger and others, 1979; Selkregg, 1974; Shasby, unpub. mapping, 1985; Spetzman, 1959; U.S. Fish and Wildlife Service, 1987a, 1987b; U.S. Forest Service, 1992; Viereck, 1989; Viereck and Little, 1972; Viereck and others, 1986, 1992; Wibbenmeyer and others, 1982) were used for this project. Descriptive information on vegetation for Alaskan ecoregions that border Canada was augmented using a publication by Oswald and Senyk (1977).

We also used surrogate information regarding the distribution of vegetation, such as statewide maps of major ecosystem types (Joint Federal-State Land Use Planning Commission for Alaska, 1973; Viereck and Little, 1972) and maps of characteristics related to photosynthetic activity (Markon and others, 1995). The latter refers to a collection of data sets derived from twice–monthly composites of advanced very high resolution radiometer (AVHRR)[9] sensor data that were available for the 1991 (Binnian and Ohlen, 1992) growing season. Each twice–monthly composite represents the five–band sensor data for the acquisition date having the highest Normalized Difference Vegetation Index[10] (NDVI) value for each pixel. The conceptual basis for the composite is that the highest NDVI value represents conditions of least atmospheric interference during data acquisition (Loveland and others, 1991). The products derived from these composites (hereafter referred to as the "derivative products") include maps of the (1) temporal classification of composite NDVI values over a growing season (resulting in 80 "greenness" classes; methodology for deriving this type of classification has been described in Loveland and others, 1991), (2) duration of greenness (number of days, per greenness class, that the NDVI value exceeded a threshold value of 0.10), (3) yearly maximum NDVI (maximum NDVI per pixel for a growing season), (4) mean NDVI (the average twice–monthly composite value per pixel), (5) onset of greenness (the composite period during which the NDVI value for a given pixel rose above 0.10), and (6) period of peak greenness (the composite period during which the maximum NDVI value occurred for each pixel). Another derivative product that proved particularly useful for capturing spatial trends in vegetative characteristics is a relative color–infrared representation (hereafter referred to as the "relative CIR image") of the 80 greenness classes (Fleming, 1994).

The AVHRR data products were not used to delineate the actual boundaries of ecoregions because these data represent characteristics detected over a single growing season. The annual variation in these characteristics has not been analyzed, so it is difficult to determine how well a single growing season represents long–term landscape patterns. We used the AVHRR data products to aid in the interpretation of the spatial patterns shown on the rest of the reference maps.

Wildfire. – Although not used to delineate ecoregions, information on wildfire has been included in the descriptions. Wildfire information in this report is limited to fires

[9] The AVHRR, mounted on National Oceanic and Atmospheric Administration (NOAA) satellites, has a polar, sun–synchronous orbit. The AVHRR sensor offers spatial resolution of approximately 1 km^2 (after geographic correction) and collects data in the red–visible, near–infrared, mid–infrared, and thermal–infrared wavelengths.

[10] An NDVI value is calculated for each pixel by using the following equation: (Near IR – Visible)/(Near IR + Visible). This ratio relates to a measure of relative photosynthetic activity; that is, the higher the NDVI value, the greater the level of photosynthetic activity (Eidenshink, 1992). However, NDVI values can be misleading because of the effects that clouds, background soil color, and surface texture have on the original visible and near–IR reflectance values (Huete and Jackson, 1988; Huete and others, 1985).

started by natural causes. Human–caused fires are not discussed because they are concentrated primarily along highways and in settled areas and are not necessarily indicative of natural regional ecological processes. Information on the occurrence of lightning fires was obtained from Gabriel and Tande (1983), and somewhat augmented from Selkregg (1974). The report by Gabriel and Tande summarized data from a 23–year span (1957–1979). Information in the current report, therefore, does not represent wildfires outside of this interval.

Land use. – Although not used to delineate ecoregions, information on extractable resources and subsistence land use has been included in the descriptions. Extractable resource information was compiled from the U.S. Bureau of Mines (1992a; 1992b), Selkregg (1974), and Pittman (1992). Information on subsistence land use came from Langdon (1993), Morgan (1979), and Selkregg (1974).

Wildlife. – Information on wildlife was not used to delineate ecoregions. Wildlife is an important component of the Alaskan landscape; however, it was beyond the scope of this report to describe the distribution and density of important species across individual ecoregions.

ECOREGION DESCRIPTIONS

Ecoregion descriptions have been compiled from the references listed in the Materials Section. An attempt has been made to provide consistent types of information for each ecoregion, but variations in the quality and quantity of information available have sometimes hindered this objective. A State map of selected features (fig. 1) precedes these descriptions to assist readers unfamiliar with locations that are mentioned.

The description of each ecoregion has been divided into the following topics: Distinctive Features, Climate, Terrain, Soils, Vegetation, Wildfire, Land Use and Settlement, Delineation Methods, and References. The general contents of each topic are described below.

Distinctive Features. – Approximate location and size of the ecoregion are described. Information on the primary factors that distinguish it from the rest of the ecoregions has been extracted from the subsequent paragraphs describing that ecoregion.

Climate. – Overall climatic regime is described in terms of major influencing factors (coastal, continental, transitional, arctic), winter and summer temperatures, and annual precipitation. Annual precipitation refers to the water equivalent (for both rain and snow) per year, and annual snowfall refers to cumulative depth. Weather stations are poorly distributed across most ecoregions. Because the available data provide an imprecise representation of regional climate in most ecoregions, we have rounded the figures to the nearest 10 mm for total annual precipitation and 5 cm for total annual snowfall.

Terrain. – Information about physiography, geology, extent of glaciation and permafrost, and hydrologic features is provided. Elevation information is based on height (meters) above mean sea level.

Soils. – Principal soils are listed and parent materials are described.

Vegetation. – Major community types are described and common or typifying species are listed. Names of community types and species closely follow those described by Viereck and others (1992). For the purposes of this report, *Equisetum* (horsetail) species are considered herbaceous vegetation in the sense that they are nonwoody. Appendix 3 is a list of Latin and common names for plant species mentioned in this report.

Wildfire. – Frequency of lightning fires for each ecoregion has been classified based on the following categories[11]: very low (<1 fire/yr.), low (1–5 fires/yr.), common (6–10 fires/yr.), very common (11–20 fires/yr.), and frequent (>20 fires/yr.; the only region in this last category averages more than 80 fires per year). The range and the average area burned are also provided. Other descriptive information is included where available.

Land Use and Settlement. – Information is provided regarding native human subsistence and selected commodities, such as resource extraction, agriculture, and timber harvest. Listings of extractable resources for an individual region generally follow the frequency of occurrence (from high to low) in the Bureau of Mines data base .

Delineation Methods. – Specific materials used to decide boundary placement on the basis of synthesized characteristics typifying each ecoregion are discussed. Although nearly all information described above (except land use) was assessed to evaluate regional patterns, only a small subset of the material was used to delineate the boundaries. This subset represents maps that best integrate the spatial patterns of the full set of characteristics defining each ecoregion. Scientists from Environment Canada and Agriculture Canada assisted in the delineation of regional boundaries that cross the international border into Canada.

References. – A list of specific references used to com-

[11]Wildfire information was obtained from Gabriel and Tande (1983). Because their reporting units did not coincide completely with ecoregion boundaries, data were summarized (using the actual frequency values provided in the original report) to a coarser class of information.

pile each ecoregion description is included.

101.[12] ARCTIC COASTAL PLAIN

Distinctive Features. – As the northernmost ecoregion in Alaska, the 50,000–km^2 Arctic Coastal Plain Ecoregion is bounded on the north and the west by the Arctic Ocean and stretches eastward nearly to the international boundary between Alaska and the Yukon Territory, Canada. The poorly drained, treeless coastal plain rises very gradually from sea level to the adjacent foothills. The region has an arctic climate, and the entire area is underlain by thick permafrost. Because of poor soil drainage, wet graminoid herbaceous communities are the predominant vegetation cover, and numerous thaw lakes dot the region (fig. 2).

Climate. – The coastal plain has arctic climatic conditions, with very low mean annual temperatures and very low annual precipitation. Although July and August are generally frost–free, freezing temperatures can occur in any month of the year. Winds are persistent and strong. The few weather stations in this region are primarily located along the coast, but the data are fairly consistent from station to station. Average daily minimum winter temperatures are about -30°C, and average daily maximum winter temperatures are about -21°C. Daily minimum summer temperatures average just above freezing, and daily maximum summer temperatures average 8°C. Continuous sunlight during the summer months yields diurnal temperature fluctuations of only about 5°C. Cloud cover or fog prevails during the summer months, although fog decreases (and temperature rises) with increasing distance from the coast. The ecoregion receives approximately 140 mm of precipitation[13] annually. Average annual snowfall varies among weather stations, ranging from 30 cm to 75 cm.

Terrain. – The ecoregion is mainly a smooth plain rising very gradually (slope gradients $\leq$1°) from the Arctic Ocean to the foothills of the Brooks Range, 180 m above sea level. Locally, permafrost–related features mark the terrain surface. Pingos rise 6 m to 70 m above the surrounding area, and other ice–related features, such as extensive networks of ice–wedge polygons, oriented lakes (ranging from a few meters to 15 km in length), peat ridges, and frost boils are common. Northeast–trending sand dunes, 3 m to 6 m high, occur between the Kuk and Colville Rivers.

The coastal plain is mantled with Quaternary deposits of alluvial, glacial, and aeolian origin. Siltstone and sandstone lie beneath the unconsolidated materials at depths of several meters to tens of meters. The ecoregion was not glaciated during the Pleistocene epoch, but the arctic climate is responsible for permafrost to depths of more than 300 m. The permafrost table is at or near the ground surface, with an active layer of less than 0.50 m (except beneath the larger rivers, where thawing may be deeper).

The Arctic Coastal Plain is very poorly drained. Thaw lakes cover 20 percent to 50 percent of the land surface across the region. In many areas, for example, near Teshekpuk Lake, lakes are rectangular and oriented north–northwest. This orientation is related to the effects of predominant winds on the permafrost shorelines of thaw lakes. Thaw lakes expand approximately 1 m per year in places and range from less than 1 m to 7 m in depth. Lake bottoms are usually covered by organic muck. Streams originate in the highlands of ecoregions to the south. Streams west of the Colville River tend to be sluggish and meandering; those east of the Colville River are more braided and distributary, building deltas into the Arctic Ocean. Most of the smaller streams dry up or freeze during the winter and have clean sand or gravel beds.

Soils. – The principal soils of the Arctic Coastal Plain are Histic Pergelic Cryaquepts and Pergelic Cryaquepts. Soils are poorly drained and have developed under thick vegetation cover. Very poorly drained fibrous peat soils occupy broad depressions, shallow drainages, and lake borders, commonly under a thick cover of sedges. Pergelic Cryopsamments have developed on low, stabilized sand dunes. Very gravelly soils form from stream deposits in braided and distributary channels of streams west of, and including, the Sagavanirktok River. Lower parts of the terrain are subject to annual flooding from runoff of spring snowmelt and heavy summer rainstorms in the upper, mountainous reaches of their watersheds. East of the Colville River are extensive areas of loamy and poorly drained soils that have formed beneath a cover of sedge tussocks, mosses, and low shrubs in nonacid and calcareous sediments.

Vegetation. – The distribution of vegetation communities is strongly related to microtopographic features that affect soil drainage. Wet soil conditions are most typical of this ecoregion, supporting wet graminoid herbaceous communities dominated by sedges or grasses (fig. 3). Dryer soil conditions occur where slight rises in microtopographic relief provide a rooting zone above the standing water table, such as along the rims of old lake basins, on river, lake, and coastal bluffs, and on pingos. Dwarf scrub communities grow in these better drained areas (fig. 4).

Sedge communities are generally dominated by *Carex aquatilis* and *Eriophorum angustifolium.* Various herbaceous species may share dominance with sedges in some areas. Mosses (usually *Scorpidium spp.* or *Drepanocladus spp.*) may be common.

[12]Numbers in front of ecoregion headings correspond with those used on the map "Ecoregions of Alaska."

[13]The average annual precipitation figure for all ecoregion descriptions includes the snow water equivalent.

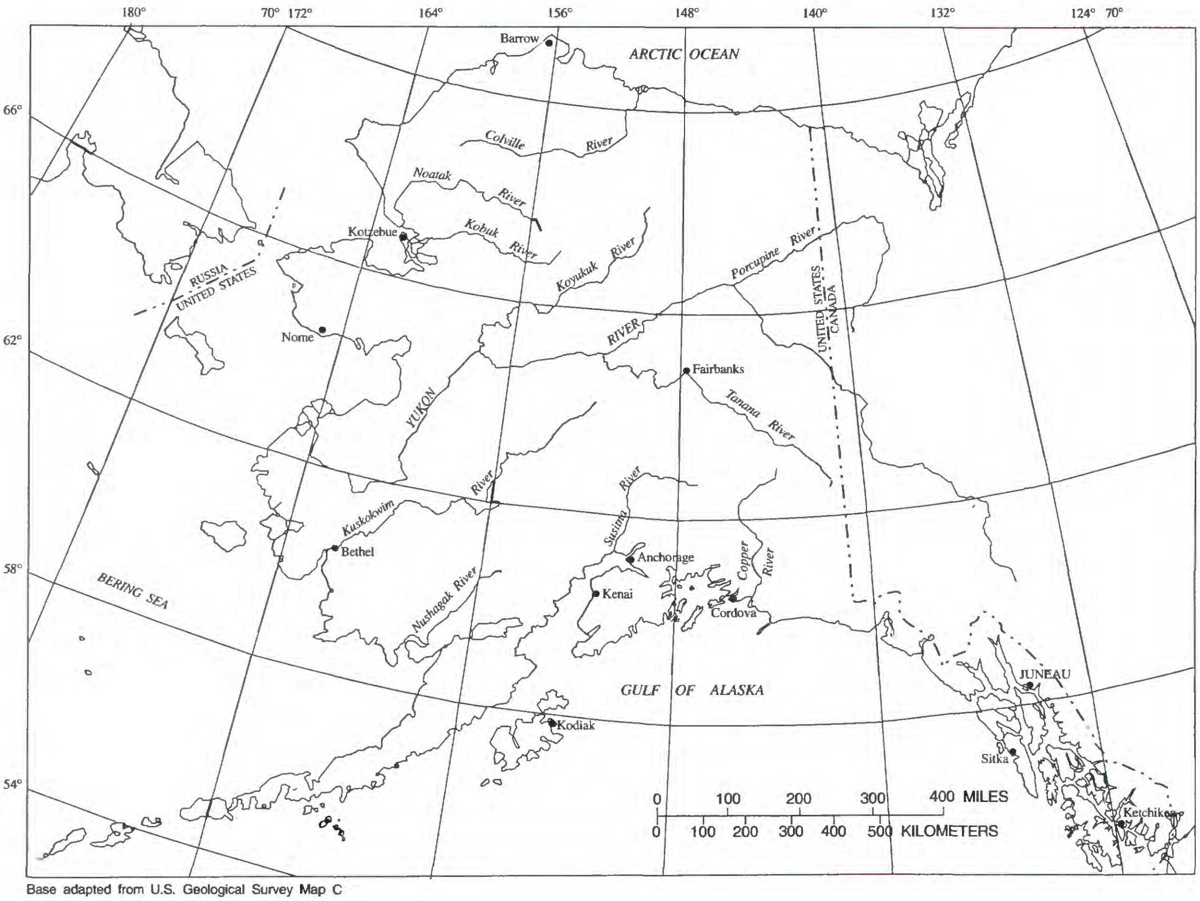

Figure 1. Locational map of Alaskan features.

Figure 2. Thaw lakes scattered over the treeless Arctic Coastal Plain Ecoregion. Many are oriented north-northwest, as in this area east of the Kuparuk River.

Figure 3. Wet graminoid herbaceous community dominated by sedge (*Carex* and *Eriophorum* species) in the Arctic Coastal Plain Ecoregion. (Photo taken by Carl Markon, Hughes STX Corporation, U.S. Geological Survey, EROS Alaska Field Office, Anchorage.)

Figure 4. Dwarf scrub community indicative of dryer soil conditions occurring on raised topographic features (approximately 10 cm or more above the surrounding plain) in the Arctic Coastal Plain Ecoregion. (Photo taken by Carl Markon, Hughes STX Corporation, U.S. Geological Survey, EROS Alaska Field Office, Anchorage.)

Grass communities are generally dominated by *Dupontia fischeri* and *Alopecurus alpinus*, but *Arctophila fulva* dominates where surface water is 15 to 200 cm deep. Various herbaceous species may share dominance with grasses in some areas.

Dwarf scrub communities commonly include entire–leaf mountain–avens (*Dryas integrifolia*), mountain–cranberry (*Vaccinium vitis–idaea*), four–angled cassiope (*Cassiope tetragona*), bearberry (*Arctostaphylos alpina* and *A. rubra*), and willows (*Salix reticulata* and *S. phlebophylla*).

Wildfire. – Occurrence of wildfires in the Arctic Coastal Plain Ecoregion is very low. Fire records show a range in size from 1 ha to 3,400 ha, with an average size of 1,135 ha.

Land Use and Settlement. – Native inhabitants of this region are Inuit (Taremiut) who have traditionally depended heavily on large marine mammals (for example, bowhead whales, beluga whales, and walrus) for food and materials. Winter ice fishing and seal hunting supplement these food supplies. Caribou are hunted during late spring, following the conclusion of the major whale hunts. Edible plant roots and summer waterfowl and their eggs add variety to the diet.

The ecoregion is rich in energy related commodities, including oil, gas, and coal. The Prudhoe Bay area has played a major role in providing these commodities. A number of sand and gravel operations support construction and road maintenance.

Delineation Methods. – The reference that best depicted the integration of important regional characteristics was the terrain roughness map. The ecoregion boundary corresponds with the pattern of continuous, very low terrain roughness. This boundary encompasses the full extent of "Wet Tundra" ecosystems shown on the arctic portion of the "Major Ecosystems of Alaska" map, as well as the thaw lakes shown on the USGS Map E base map. Some inclusions of "Moist Tundra" from the map "Major Ecosystems of Alaska" also occur, and are depicted as transitional gray tones on the ecoregion map. Patterns on the relative CIR image reflect a combination of those shown on the surface roughness map and those shown on the ecosystems map; so the image is generally in agreement with the ecoregion boundary.

References. – The information provided in this regional description has been compiled from: Beikman (1980), Black (1951, 1955, 1969), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), Spetzman (1959), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

102. ARCTIC FOOTHILLS

Distinctive Features. – The 124,000–km^2 Arctic Foothills Ecoregion consists of a wide swath of rolling hills and plateaus that grades from the coastal plain on the north to the Brooks Range on the south. The east–west extent of the ecoregion stretches from the international boundary between Alaska and The Yukon Territory, Canada, to the Chukchi Sea. The hills and valleys of the region have better defined drainage patterns than those found in the coastal plain to the north and have fewer lakes (fig. 5). The Arctic Foothills Ecoregion is underlain by thick permafrost and has many ice–related surface features. The region is predominantly treeless and is vegetated primarily by mesic graminoid herbaceous communities.

Climate. – Arctic climate prevails in this ecoregion. The foothills are somewhat warmer in winter than the adjacent regions to the north and south, and gain some ameliorating effects from the Chukchi Sea to the west. Weather stations are rare in the Arctic Foothills Ecoregion, and information from the few data locations and anecdotal accounts may not be representative. Annual precipitation mirrors that of the Arctic Coastal Plain (≈140 mm). As much as 50 mm of additional precipitation is intercepted near the boundary with the Brooks Range Ecoregion. The Noatak Valley, in the western portion of the Arctic Foothills Ecoregion, receives approximately twice as much annual precipitation as the rest of the region. Snowfall patterns are similar to overall annual precipitation patterns in that more snowfall occurs near the Brooks Range (up to 130 cm) and in the Noatak Valley (up to 150 cm) than throughout the rest of the region (75 cm to 100 cm). Average daily winter temperatures range from a minimum of -29°C to a maximum of -20°C. Average daily summer temperatures range from a minimum of 1°C to a maximum of 11°C to 15°C, although maximum temperatures of 24°C are not uncommon in some areas. Freezing can occur in any month of the year, but July and August are usually frost–free.

Terrain. – The Arctic Foothills Ecoregion can be topographically and geologically separated into northern and southern sections. The northern section consists of broad, rounded east–west ridges and mesa–like uplands built from unconsolidated Quaternary materials (glacial, alluvial, and aeolian in origin) over Lower Cretaceous continental deposits. Elevations are generally less than 600 m above sea level. The southern section has undifferentiated alluvial and colluvial deposits overlying Jurassic and early Cretaceous graywacke and chert formations. Elevations are higher than in the northern section (up to 800 m) and consist of irregular buttes, mesas, and long linear ridges with intervening undulating plains and plateaus.

The ecoregion was free from Pleistocene glaciation (except for some areas directly north of the Brooks Range) but is currently underlain by thick permafrost. The active layer of the permafrost is generally less than 1 m, except beneath large rivers, where thawing may be deeper. Many ice–related features are present, such as pingos, gelifluction lobes, ice–wedge polygons, stone stripes, and beaded drainage (fig. 6). Although regional slope gradients generally vary from 0° to 5°, they may be steeper in some areas.

Drainage in the Arctic Foothills Ecoregion is integrated. Major streams originate from the Brooks Range and are structurally controlled by the bedrock. Most streams are swift, but portions may be braided across gravel flats. Smaller streams dry up or freeze to the bottom in winter; these streams typically have clean sand or gravel bottoms. Perennial streams have algae–covered rocky bottoms. During spring snowmelt and breakup of river ice, flooding and channel shifting are common. Oxbow lakes along major stream valleys are the predominant type of lake in this ecoregion. Most lake beds are organic muck, but some are sandy. Lake shores are surrounded by ice–push ridges (as much as 2 m high). Plant communities in lakes are generally arranged in concentric bands that correspond with water depth; aquatic vegetation is usually limited to water that is less than 1.5 m deep.

Soils. – Principal soils are Histic Pergelic Cryaquepts, Pergelic Cryaquepts, and Pergelic Ruptic–Histic Cryaquepts. Dominant soils in valleys and on long slopes formed in silty or loamy colluvial sediments. On hills and ridges, most of the soils are composed of very gravelly materials eroded from sedimentary rock. The dominant soils in the Noatak Valley are poorly drained and are derived from very gravelly glaciofluvial material from limestone rock in the surrounding mountains. Well drained soils occur on hilly moraines of the valley, formed from very gravelly, nonacid and calcareous drift. Shallow depressions on terraces accommodate fibrous peat soils.

Vegetation. – Vegetation over most of the region consists of mesic graminoid herbaceous (fig. 7) and dwarf scrub communities. Open low scrub occurs along drainages. Forest communities occur in the Noatak River Valley, a somewhat anomalous area of this ecoregion.

Mesic graminoid herbaceous communities dominated by tussock–forming sedges are widespread. Typical species are *Eriophorum vaginatum* and *Carex bigelowii.* Low shrubs, such as dwarf arctic birch (*Betula nana*), crowberry (*Empetrum nigrum*), narrow–leaf Labrador–tea (*Ledum decumbens*), and mountain–cranberry (*Vaccinium vitis–idaea*) often occur and may codominate with sedges. Mosses (for example, *Hylocomium splendens* and *Sphagnum spp.*) and lichens (for example, *Cetraria cucullata, Cladonia spp.*, and *Cladina rangiferina*) are common between tussocks.

Dwarf scrub communities are dominated by mat–forming *Dryas* species accompanied by ericaceous species (for example, *Vaccinium spp., Cassiope tetragona, Arctostaphylos spp.*) and prostrate willows (*Salix reticulata* and *S. phlebophylla*).

Open low scrub communities are codominated by alders (*Alnus crispa*) and willows (for example, *Salix lanata, S. planifolia*, and *S. glauca*). Mosses (for example, *Tomenthypnum nitens* and *Drepanocladus spp.*) are usually abundant.

Forest vegetation is common along river terraces of the lower Noatak Valley (as far inland as the Kugururok River). White spruce (*Picea glauca*) occurs in either pure stands or with balsam poplar (*Populus balsamifera*). The spruce grows in open stands along the riverbanks, with an understory dominated by willows (for example, *Salix alaxensis, S. planifolia*, and *S. lanata*). Away from the river, forest canopies are closed and stands have few understory species (for example, ericads such as *Ledum spp., Arctostaphylos spp.*, and *Vaccinium spp.*). A thick layer of feathermosses (for example, *Hylocomium splendens*) is common. Balsam poplar stands grow all along the river, occurring farther upriver than white spruce stands. Typical understory species are alpine bearberry (*Arctostaphylos alpina*), buffaloberry (*Shepherdia canadensis*), and bush cinquefoil (*Potentilla fruticosa*).

Wildfire. – Occurrence of wildfires in the Arctic Foothills Ecoregion is very low. Fire records show a range in size from <1 ha to 1,600 ha, with an average size of 185 ha.

Land Use and Settlement. – The ecoregion has traditionally been home to the Inuit (Nunamiut). Caribou is the primary subsistence resource. Moose, bear, hare, ground squirrel, and ptarmigan are also hunted. Edible plant roots and berries supplement the diet.

Subsistence and recreational fishing and hunting remain the primary human activities in this ecoregion. A number of potential extractable resources have been investigated, including coal, barium, lead, chromium, zinc, and silver. Sand and gravel operations have supported construction of the trans–Alaska pipeline service road.

Delineation Methods. – Typical characteristics of the Arctic Foothills Ecoregion are integrated within the area of low terrain roughness on the arctic portion of the terrain roughness map. The ecoregion boundary shared with the Arctic Coastal Plain was delineated on the basis of a distinct boundary between very low terrain roughness and low terrain roughness. The ecoregion boundary shared with the Brooks Range was delineated along a generalized 600–m elevation contour, an elevation coinciding with the northern extent of "Alpine Tundra" in the Brooks Range, as depicted on the "Major Ecosystems of Alaska" map. This contour line corresponds well with regional patterns shown on the relative CIR image. The ecoregion boundary shared with Interior Forested Lowlands and Uplands was based on the interface of the forest ecosystems of the interior and the tundra (graminoid herbaceous) ecosystems of the Arctic. Transitional areas adjacent to the Brooks Range indicate

Figure 5. Rolling hills of the Arctic Foothills Ecoregion showing better defined drainage patterns than those found in the coastal plain to the north. (Photo courtesy of Skip Walker, Institute of Arctic and Alpine Research, University of Colorado, Boulder.)

Figure 6. Beaded stream drainages controlled by the pattern of ice wedges formed in permafrost environments of the Arctic Foothills Ecoregion. (Photo courtesy of Skip Walker, Institute of Arctic and Alpine Research, University of Colorado, Boulder.)

Figure 7. Mesic graminoid herbaceous-dwarf scrub community near Umiat in the Arctic Foothills Ecoregion. (Photo courtesy of Skip Walker, Institute of Arctic and Alpine Research, University of Colorado, Boulder.)

Figure 8. The Brooks Range Ecoregion is composed of deeply dissected mountains formed from uplifted, stratified Paleozoic and Mesozoic sediments.

alpine tundra ecosystems, areas greater than 600 m in elevation, and areas of medium to high terrain roughness. Transitional areas adjacent to the Arctic Coastal Plain indicate inclusions of areas of very low terrain roughness.

References. – The information provided in this regional description has been compiled from Beikman (1980), Black (1951, 1955, 1969), Coulter and others (1962), D. Binkley (oral commun., 1994), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), Spetzman (1959), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

103. BROOKS RANGE

Distinctive Features. – The 134,000–km^2 Brooks Range Ecoregion consists of several groups of rugged, deeply dissected mountains carved from uplifted sedimentary rock (fig. 8). The ecoregion traverses much of the east–west extent of northern Alaska, from the Canadian border to within 100 km of the Chukchi Sea. Elevation of mountain peaks ranges from 800 m in the relatively low Baird Mountains in the west to 2,400 m in the central and eastern Brooks Range. Pleistocene glaciation was extensive, and small glaciers persist at elevations above 1,800 m. An arctic climatic regime and unstable hillslopes maintain a sparse cover of dwarf scrub vegetation throughout the mountains, though some valleys provide more mesic sites for graminoid herbaceous communities.

Climate. – The ecoregion is influenced by arctic climate. The only perennial weather station, located at Anaktuvuk Pass, sits at an elevation of 770 m, where winter temperatures average a daily minimum of -30°C and a daily maximum of -22°C, and summer temperatures average lows of 3°C and highs of 16°C. In most years, freezing temperatures occur each month. In general, temperatures decrease with elevation, but hillslope aspect, strong and persistent winds, and convective currents result in climate that is highly variable. Mean annual precipitation at Anaktuvuk Pass is 280 mm, with 160 cm of annual snowfall. Precipitation is heaviest on south–facing slopes and near mountain summits.

Terrain. – The Brooks Range Ecoregion represents the Alaskan extension of the Rocky Mountains. The steep, rugged mountains consist of folded and faulted stratified Paleozoic and Mesozoic sedimentary deposits (including sandstone, shale, and limestone marine and nonmarine deposits, and some metamorphic rocks) that were uplifted during the Cretaceous period. Elevations range from 500 m in the lower valleys to 2,400 m on the higher peaks. Slope gradients of 5° to 15° are common. The ecoregion was extensively glaciated during the Pleistocene epoch, but only small, scattered glaciers persist. Continuous thick permafrost underlies the region. The interplay between water (frozen and thawed) and sediments is evidenced by moraine and gravel outwash terraces in most valleys, by gelifluction lobes on hillslopes, by ice–push ridges around lakes, and by polygons, stripes, and circular frost scars on many surfaces. Rubble and exposed bedrock cover the mountain slopes.

Lakes are sparse for such a glacially influenced region, occurring primarily in rock basins at the mouths of large glaciated valleys, in areas of ground and end moraine, and on the floodplains of major streams. Streams often have a trellis drainage pattern, with major streams draining north or south and their tributaries draining east or west. Extensive alluvial fans of loose material carried down from mountain slopes have formed in broad valleys at the base of streams. Hot springs are known to occur in several areas.

Soils. – The principal soils of the Brooks Range Ecoregion are Pergelic Cryaquepts, Pergelic Cryumbrepts, and Lithic Cryorthents. Hillslope soils formed from local colluvium, while most valley soils generally developed from glacial till. Soils are often gravelly, but are covered in many places with silty colluvial and residual material from fine–grained sedimentary rocks. Because of glaciation, frost action, and rapid erosion of steep slopes, there is little soil accumulation on hillslopes. Soils throughout this ecoregion typically have poor drainage because of the shallow depth to permafrost.

Vegetation. – Because of highly erodible hillslope sediments, shallow soils, high winds, and harsh climate in this ecoregion, vegetation cover is sparse (fig. 9) and generally limited to valleys and lower hillslopes. Drier sites support dwarf scrub communities. Wet to mesic sites support mesic graminoid herbaceous communities.

Dwarf scrub communities are dominated by ericaceous species (for example, *Arctostaphylos alpina*, *A. rubra*, *Vaccinium spp.*, *Ledum decumbens*, *Empetrum nigrum*, and *Cassiope tetragona*), mountain–avens (*Dryas octopetala* and *D. integrifolia*), and willow (*Salix rotundifolia*, *S. arctica*, and *S. polaris*). Herbaceous species (for example, *Carex spp.*) and fruticose lichens (for example, *Cladina spp.* and *Cetraria spp.*) may codominate with shrubs in some areas (fig. 10).

Graminoid herbaceous communities are dominated by sedges (*Carex aquatilis* and *C. bigelowii*) and willows (*Salix planifolia* and *S. lanata*). Mosses (for example, *Tomenthypnum nitens*, *Distichium capillaceum*, *Drepanocladus spp.*, and *Campylium stellatum*) are often abundant.

Wildfire. – Occurrence of wildfires in the Brooks Range

Figure 9. Steep, unstable slopes of the Brooks Range Ecoregion. Physiography and an arctic climate restrict vegetation.

Figure 10. Dwarf scrub community dominated by mountain-avens and lichen growing on a windswept site of the Brooks Range Ecoregion. (Photo courtesy of Skip Walker, Institute of Arctic and Alpine Research, University of Colorado, Boulder.)

Ecoregion is common. Fire records show a range in size from <1 ha to 109,265 ha, with an average size of 1,790 ha.

Land Use and Settlement. – The Brooks Range has historically been used by nomadic groups of the Interior North Alaska Coast Inuit (Nunamiut) and by the Kutchin and Koyukon Athabascans. Salmon fishing and hunting for caribou and moose are the major means of subsistence. Small fur–bearing mammals are hunted secondarily. Edible plants are also gathered.

The fact that Anaktuvuk Pass is the only year–round settlement in this ecoregion underscores the harsh environment and difficulty of transportation associated with the mountains. The region is little developed and provides subsistence hunting and fishing, as well as recreational uses. Many extractable resources have been investigated and, in some cases, mined. These include gold, silver, copper, tungsten, zinc, lead, chromium, vanadium, antimony, barium, molybdenum, phosphate, and rare earth elements. Numerous sand and gravel operations have supported construction of the trans–Alaska pipeline service road.

Delineation Methods. – The ecoregion boundary primarily follows a generalized 600–m elevation contour. An exception occurs in the southeastern part of the ecoregion, where a 900–m contour was used. This is because the mountains at the 600–m level in the southeast are more widely spaced, have climatic characteristics more similar to those of interior regions, and have a different geologic origin than the rest of the Brooks Range. The boundary delineated generally corresponds with patterns shown on the relative CIR image. The transitional zones on the northern side of the ecoregion distinguish areas of "Moist Tundra," as depicted on the map "Major Ecosystems of Alaska," and lower elevation valleys penetrating from the Arctic Foothills Ecoregion. Transitional zones on the southern side distinguish "Upland Spruce–Hardwood Forest" ecosystems, as depicted on the map "Major Ecosystems of Alaska," along drainages adjacent to interior ecoregions.

References. – The information provided in this regional description has been compiled from Beikman (1980), Black (1955, 1969), Coulter and others (1962), Ferrians (1965), Ferrians and Hobson (1973), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), Spetzman (1959), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

104. INTERIOR FORESTED LOWLANDS AND UPLANDS

Distinctive Features. – The 269,000–km^2 ecoregion represents a patchwork of ecological characteristics. Regionwide unifying features include a lack of Pleistocene glaciation, a continental climate, a mantling of undifferentiated alluvium and slope deposits, a predominance of forests dominated by spruce and hardwood species, and a very high frequency of lightning fires. On this backdrop of characteristics is superimposed a finer grained complex of vegetation communities resulting from the interplay of permafrost, surface water, fire, local elevational relief, and hillslope aspect (fig. 11).

Climate. – The ecoregion has a continental climate, with short, warm summers and long, very cold winters. Because the ecoregion is so large, there is much variation in temperature and precipitation from west to east. Total annual rain and snow generally increase with elevation. Temperature, while affected by elevation, is also influenced by distance from the ocean; maximum summer temperatures increase from west to east, and minimum winter temperatures decrease in the same pattern. Accordingly, variation in diurnal temperature increases from west to east.

Mean annual precipitation over most of the region ranges from 250 mm to 550 mm, with contribution from snowfall averaging from 125 cm to 205 cm. Most precipitation occurs during summer, mainly as a result of convective storms. Snow covers the landscape for half the year, lingering at higher altitudes, on north–facing slopes, and on shaded aspects. Average minimum winter temperatures vary from -18°C in the west to -35°C in the east; average maximum winter temperatures vary from -11°C in the west to -22°C in the east. Strong, stable temperature inversions are common in winter due to low sun angle and corresponding long–wave radiation cooling. Summer temperatures, averaging a minimum of 8°C to 11°C and a maximum of 17°C to 22°C, have less regional variation than winter temperatures. At lower elevations, temperatures usually remain above freezing from June through mid–September.

Terrain. – The Interior Forested Lowlands and Uplands Ecoregion consists of rolling lowlands, dissected plateaus, and rounded low to high hills. Most of the region lies between elevations from sea level to 500 m, but some hills rise over 700 m. Slope gradients are generally from 0° to 5°. The predominant geologic formations are derived from Mesozoic and Paleozoic sedimentary rocks, but extensive areas of volcanic deposits also occur. The region is surficially mantled by undifferentiated alluvium and slope deposits. There is little exposure of bedrock. Streams originating from within the ecoregion tend to be short, with the larger and longer streams originating from adjacent glaciated mountainous regions. Although thaw lakes and oxbow lakes occur throughout the ecoregion, lakes are not a pre-

Figure 11. Forest plant communities typical of the Interior Forested Lowlands and Uplands Ecoregion. The patterns and species composition of the communities are often controlled by the effects of permafrost, surface water, fire, relief, and hill-slope aspect.

Figure 12. Initial recolonization by fireweed within recent burn, east of Tok in the Interior Forested Lowlands and Uplands Ecoregion. High frequency of lightning fires is a common characteristic.

dominant landscape feature. The western portion of the ecoregion is underlain by thin to moderately thick permafrost, and the eastern portion has a discontinuous distribution of permafrost. The region was not glaciated during the Pleistocene epoch.

Soils. – Dominant soils of this ecoregion are Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, Pergelic Cryochrepts, Typic Cryochrepts, Typic Cryorthents, and Pergelic Cryumbrepts. Many upland soils were formed in silty, micaceous loess and colluvial material. Where mantles of loess are lacking, upland soils formed in stone and gravel weathered from local rock. Lowland soils were formed in silty alluvium and loess derived from the floodplains of large rivers. Soils are generally shallow, often overlying ice–rich permafrost. Those soils with permafrost, especially in the eastern portion of the ecoregion, are very susceptible to alteration upon disturbance of the organic mat. This is due to the relatively warm (>-1.5°C) permafrost temperature. Organic mat disturbance, as by wildfire, can result in warmer soil temperatures, lowered permafrost tables, and significant changes in soil physical properties and hydrology.

Vegetation. – Interrelationships among permafrost, surface water, fire, hillslope aspect, and soil characteristics result in a finely textured, complex pattern of vegetation across the ecoregion. Soil temperatures may differ greatly from air temperatures, so patterns in vegetation may not correspond with expected site conditions. Needleleaf, broadleaf, and mixed forests occur over a variety of sites. Tall scrub communities grow in areas of newly exposed alluvium, such as floodplains, streambanks, drainageways, and lake margins, on burned or otherwise disturbed areas, and near timberline. Low scrub communities occur in moist areas and on north–facing slopes. The wettest sites support tall scrub swamps, low scrub bogs, or scrub–graminoid communities. Recently burned areas (fig. 12) display a succession of recovery stages that include mesic forb herbaceous communities, mesic graminoid herbaceous communities, scrub communities, and broadleaf, needleleaf, and mixed forests.

Needleleaf forests are dominated by spruce and occur over a variety of site conditions. White spruce (*Picea glauca*) occurs on warm, dry, south–facing hillslopes, along rivers where drainage is good and permafrost is lacking, and on well drained timberline sites. Dominant components of the understory include shrubs, such as resin birch (*Betula glandulosa*), prickly rose (*Rosa acicularis*), alder (*Alnus spp.*), willow (*Salix spp.*), buffaloberry (*Shepherdia canadensis*), high bushcranberry (*Viburnum edule*), and bearberry (*Arctostaphylos spp.*); herbs, such as twinflower (*Linnaea borealis*); and mosses, such as *Hylocomium splendens*, *Pleurozium schreberi*, and *Cladonia spp.*

Black spruce (*Picea mariana*) forests are found on floodplain terraces and flat to rolling uplands in well drained to poorly drained soils. Tamarack (*Larix laricina*) may be associated with black spruce in wet bottomland areas. Low shrubs, such as Labrador–tea (*Ledum groenlandicum* and *L. decumbens*), prickly rose (*Rosa acicularis*), blueberry/cranberry (*Vaccinium spp.*), and resin birch (*Betula glandulosa*) are typically dominant in the understory. The ground has a patchy to continuous layer of mosses (for example, *Pleurozium schreberi*, *Hylocomium splendens*, *Polytrichum spp.*, and *Sphagnum spp.*), and lichens (for example, *Peltigera spp.* and *Cladonia spp.*).

Broadleaf forests of balsam poplar (*Populus balsamifera*), quaking aspen (*Populus tremuloides*), or a mix of the two develop on the floodplains of meandering rivers. These forest stands follow the establishment of alder and willow thickets. The stands are subsequently replaced by white spruce (*Picea glauca*). Dominant understory species of broadleaf forests are alder (*Alnus spp.*), willow (*Salix spp.*), prickly rose (*Rosa acicularis*), and herbaceous species (for example, *Equisetum spp.*, *Calamagrostis canadensis*, and *Heracleum lanatum*).

Mixed forests are dominated by combinations of spruce, paper birch, and quaking aspen. Dominant understory species include bluejoint (*Calamagrostis canadensis*), alder (*Alnus spp.*), bearberry (*Arctostaphylos spp.*), and Labrador–tea (*Ledum spp.*).

Most tall scrub communities are dominated by willows (*Salix alaxensis*, *S. glauca*, and *S. lanata*) and alders (*Alnus crispa*, *A. tenuifolia*, and *A. sinuata*), though communities near timberline may be dominated by birch (*Betula glandulosa* and *B. papyrifera*). Understory shrubs are usually sparse, but mosses (for example, *Polytrichum spp.*, *Hylocomium splendens*, and *Drepanocladus uncinatus*) may be abundant.

Low scrub communities are dominated by open stands of willow (for example, *Salix glauca*, *S. planifolia*, and *S. lanata*), birch (*Betula glandulosa* and *B. nana*), alder (*Alnus crispa*), or mixes of these genera. Dominant understory shrubs may include cranberry/blueberry (*Vaccinium spp.*), bearberry (*Arctostaphylos spp.*), and Labrador–tea (*Ledum spp.*). The ground is covered by a patchy to continuous layer of moss (for example, *Hylocomium splendens*, *Pleurozium schreberi*, *Tomenthypnum nitens*, and *Aulacomnium palustre*).

Tall scrub swamps are dominated by alder (*Alnus tenuifolia* and *A. crispa*) and willow (*Salix planifolia* and *S. lanata*). Low shrubs may be present in the understory, including leatherleaf (*Chamaedaphne calyculata*), high bushcranberry (*Viburnum edule*), sweetgale (*Myrica gale*), and spirea (*Spiraea beauverdiana*). Mosses (for example, *Sphagnum spp.*) are usually present.

Bogs support open low scrub or scrub–graminoid communities. The shrub component includes a number of willow species (for example, *Salix planifolia*, *S. reticulata*, *S. barclayi*, *S. commutata*, and *S. fuscescens*), birch (*Betula glandulosa* and *B. nana*), Labrador–tea (*Ledum decumbens*), blueberry/cranberry (*Vaccinium uliginosum*, *V. vitis–idaea*, and *V. oxycoccos*), bush cinquefoil (*Potentilla fruticosa*), sweetgale (*Myrica gale*), alder (*Alnus tenuifolia*), and bog–

rosemary (*Andromeda polifolia*). Sedge tussocks (*Eriophorum vaginatum* and *Carex bigelowii*) or other graminoids (for example, *Calamagrostis canadensis*, *Carex aquatilis*, and *C. pluriflora*) are codominant with shrub species in some bogs. A continuous moss layer, commonly consisting of *Sphagnum spp.*, *Pleurozium schreberi*, *Hylocomium splendens*, *Dicranum spp.*, and *Polytrichum spp.*, is present.

Recent burn areas are initially colonized by mesic forb herbaceous communities dominated by fireweed (*Epilobium angustifolium*). Mesic graminoid herbaceous communities develop when bluejoint (*Calamagrostis canadensis*) becomes dominant. The scrub communities that follow consist mainly of willows (*Salix arbusculoides*, *S. barclayi*, *S. bebbiana*, and *S. scouleriana*), accompanied by prickly rose (*Rosa acicularis*), buffaloberry (*Shepherdia canadensis*), and ericaceous species (for example, *Ledum decumbens*, *L. groenlandicum*, *Vaccinium caespitosum*, and *V. vitis–idaea*). Broadleaf forests dominated by quaking aspen (*Populus tremuloides*) often succeed the willow stage in upland areas on south–facing slopes, or on well drained river terraces. Paper birch (*Betula papyrifera*) stands succeed the willow stage on east–, west–, and occasionally north–facing slopes and flat areas. Mixed forest stands occur when spruce becomes established in the broadleaf stands. Needleleaf forests dominated by spruce eventually replace the mixed stands on many sites.

Wildfire. – Wildfires occur frequently in the Interior Forested Lowlands and Uplands Ecoregion. Fire size has ranged from less than 1 ha to 260,800 ha (the largest occurring in the Kuskokwim Mountains), with an average size of 1,630 ha. Low annual precipitation, high summer temperatures, low relative humidity, frequent lightning storms, and trees having branches low to the ground are factors that make this ecoregion especially prone to wildfire. The fire season usually lasts from June through the beginning of August.

Land Use and Settlement. – The region is used primarily for subsistence and recreational hunting and fishing. Native inhabitants have descended from a number of Athabascan groups, such as the Koyukon, Kutchin, Tanana, Han, Tanacross, Upper Tanana, Upper Kuskokwim, Holikachuk, and Ingalik. Upland dwellers rely on large game (caribou and moose) as important sources of food and materials. Riverine groups depend heavily on salmon and freshwater fish (for example, whitefish, blackfish, and pike). Smaller mammals and ptarmigan provide secondary subsistence sources. Edible and medicinal plant parts are also collected.

Investigation and extraction of metals (for example, gold, silver, tin, tungsten, mercury, lead, platinum, nickel, zinc, chromium, cobalt, columbium, and copper) occur in many areas. Energy–related resources in the region include uranium and coal. Other extractable resources are antimony, bismuth, molybdenum, thorium, and rare earth elements. Sand and gravel operations have supported construction and road building.

Delineation Methods. – The ecoregion boundary abutting the Arctic Foothills in the northwest delineates where the forest ecosystems meet the arctic tundra ecosystems, as depicted on the map "Major Ecosystems of Alaska." The boundaries adjacent to the Brooks Range, the Ogilvie Mountains, the Ahklun and Kilbuck Mountains, the Alaska Range, and the Wrangell Mountains Ecoregions are based on a generalized 600–m elevation contour. The boundary adjacent to the Interior Highlands is based on a generalized 500–m elevation contour. The boundary shared with the Interior Bottomlands and Yukon Flats Ecoregions eliminates from the Interior Forested Lowlands and Uplands Ecoregion those areas of low and very low terrain roughness that have "Bottomland Spruce–Poplar Forest," "Lowland Spruce–Hardwood Forest," or "Low Brush, Muskeg Bog" ecosystems, as shown on the map "Major Ecosystems of Alaska." The boundary adjoining the Subarctic Coastal Plains Ecoregion was based on where the coastal "Wet Tundra" and "Moist Tundra" ecosystems meet the interior forest ecosystems, also as shown on the map "Major Ecosystems of Alaska." Likewise, the boundary adjoining the Seward Peninsula was based on the extent of the forest ecosystems of the interior versus the brush and tundra ecosystems shown for the peninsula. The boundary shared with the Bristol Bay– Nushagak Lowlands Ecoregion is based on separating the coastal tundra and "Lowland Spruce–Hardwood Forest" of the Lowlands from the "Upland Spruce–Hardwood Forest" and small, scattered "Alpine Tundra" areas of the Interior. Transitional zones shown in the Interior Forested Lowlands and Uplands Ecoregion depict areas of isolated peaks greater than 600 m in elevation that are near borders of montane regions, and moist tundra ecosystems that are adjacent to coastal and bottomland regions.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Kimmins and Wein (1986), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun.,1993), Pittman (1992), Reiger and others (1979), Selkregg (1974), Slaughter and Viereck (1986), Viereck (1989), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1987a), Viereck and Little (1972), Viereck and others (1986, 1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

105. INTERIOR HIGHLANDS

Distinctive Features. – The 115,000–km^2 discontinuous Interior Highlands Ecoregion is composed of rounded, low mountains, often surmounted by rugged peaks (fig. 13). The highlands primarily sustain dwarf scrub vegetation and open spruce stands, though graminoid herbaceous communities occur in poorly drained areas. Mountains in most parts of this region rise to at least 1,200 m, and many rise higher than 1,500 m. Most of the higher peaks were glaciated during the Pleistocene epoch.

Climate. – The ecoregion has a continental climate. Although no long–term weather data are available, certain generalizations can be made regarding temperature and precipitation. First, an orographic effect on precipitation causes the highlands to receive more precipitation than the surrounding, lower elevation areas. Second, summer temperatures probably decrease with elevation. Because of steep and persistent winter temperature inversions at lower elevations, it is difficult to generalize the relative pattern of winter temperatures in the highlands versus in the surrounding areas.

Terrain. – The ecoregion consists of steep, rounded ridges, often capped by rugged peaks. Elevations range from 500 m in the valleys to greater than 1,500 m on the peaks (some peaks rise above 1,800 m). Slope gradients commonly range from 5° to 15°, but lower gradient slopes are typical around the margins of the ecoregion. The mountains have much more exposed bedrock than the surrounding hills of the Interior Forested Lowlands and Uplands Ecoregion. Geologic formations of the Interior Highlands consist of Paleozoic and Precambrian metamorphic rocks, felsic volcanic rocks, and intrusive rocks. Outlying parts of the ecoregion, in the Kuskokwim Mountains and Nulato Hills, have Cretaceous and Lower Paleozoic sedimentary rocks. The northern portions of the ecoregion are underlain by continuous permafrost, and the central and southern portions are underlain by discontinuous permafrost. Permafrost and frost–related ground features are evident, including low mounds, gelifluction lobes, frost boils, and stone stripes. Many of the peaks were glaciated during the Pleistocene epoch.

Soils. – Dominant soils are Histic Pergelic Cryaquepts, Typic Cryochrepts, Pergelic Cryumbrepts, Lithic Cryorthents, and Typic Cryorthods. Most soils are shallow, formed in very stony or gravelly material weathered from local rock. The permafrost table is shallow and soils are poorly drained; however, they are generally too shallow over bedrock for ground–ice to form. Barren, rocky peaks and stony and bouldery slopes are common. Alluvium and colluvium cover the valley floors. Soils with permafrost are very susceptible to alteration upon disturbance of the organic mat because of the relatively warm (>-1.5°C) permafrost temperature. Organic mat disturbance, as by wildfires, can result in warmer soil temperatures, lowered permafrost tables, and significant changes in soil physical properties and hydrology.

Vegetation. – The highest elevations are barren of vegetation. Dwarf scrub communities, dominated by species of mountain–avens, ericads, and willow, are widespread in sites exposed to wind. Lower elevations are generally more protected from wind and have a denser vegetation cover that can include open needleleaf forests and woodlands. Areas of poor soil drainage support mesic graminoid herbaceous communities.

Mountain–avens dwarf scrub communities are dominated by several species of *Dryas* (for example, *D. octopetala*, *D. integrifolia*, and *D. drummondii*). Sedges (for example, *Carex scirpoidea*, *C. misandra*, *C. bigelowii* and *Kobresia myosuroides*) and lichens (for example, *Alectoria spp.*, *Cetraria spp.*, and *Cladina spp.*) may codominate with *Dryas*. Also common are prostrate willows (*Salix reticulata* and *S. phlebophylla*) and ericaceous species (for example, *Vaccinium spp.*, *Cassiope tetragona*, *Arctostaphylos spp.*, and *Empetrum nigrum*). Mosses (for example, *Tomenthypnum nitens*, *Rhytidium rugosum*, and *Hylocomium splendens*) are abundant in *Dryas*–sedge communities.

Ericaceous dwarf scrub communities are also widespread. Bearberry (*Arctostaphylos alpina* or *A. rubra*) and cranberry/blueberry (*Vaccinium spp.*) are the common dominants, though other ericaceous shrubs (for example, *Ledum decumbens*, *Empetrum nigrum*, and *Cassiope tetragona*), prostrate willows (*Salix phlebophylla* and *S. rotundifolia*), and fruticose lichens (for example, *Cladina spp.*, *Cetraria spp.*, and *Stereocaulon tomentosum*) may be common or codominant. Mosses (for example, *Dicranum spp.*, *Rhacomitrium lanuginosum*, *Tomenthypnum nitens*, and *Hylocomium splendens*) are common.

Willow dwarf scrub communities are dominated by willow (for example, *Salix polaris*, *S. reticulata*, and *S. arctica*). Other dwarf shrubs (for example, *Empetrum nigrum*, *Cassiope lycopodioides*, *Dryas spp.*, *Vaccinium spp.*, and *Ledum decumbens*) are common and may codominate with willows. Mosses (for example, *Dicranum spp.* and *Aulacomnium spp.*) can be common.

Open needleleaf forests and woodlands are often dominated by white spruce (*Picea glauca*) or codominated by white spruce and black spruce (*P. mariana*). Other tree species in these communities include paper birch (*Betula papyrifera*) and quaking aspen (*Populus tremuloides*). The open shrub layer commonly includes resin birch (*Betula glandulosa*), alder (*Alnus crispa* and *A. sinuata*), willow (*Salix planifolia* and *S. lanata*), prickly rose (*Rosa acicularis*), buffaloberry (*Shepherdia canadensis*), and other ericaceous shrubs. The ground is covered by a continuous layer of mosses (for example, *Pleurozium schreberi*, *Hylocomium splendens*, *Polytrichum spp.*, and *Dicranum spp.*). Lichens (for example, *Cladonia spp.*) provide significant cover at some sites.

Mesic graminoid herbaceous communities consist of sedge tussocks (for example, *Eriophorum vaginatum* and *Carex bigelowii*) surrounded by mosses. Low shrubs (for

Figure 13. Rounded mountains, often surmounted by rugged peaks, are typical of the Interior Highlands Ecoregion. Vegetation communities consist of alpine tundra and open spruce stands.

Figure 14. Relatively flat terrain of Interior Bottomlands Ecoregion. Soil drainage is usually poor. Black spruce and low ericaceous shrubs are common on slightly raised peat deposits. Various forbs and graminoid species occur in vegetated wetlands. Vegetation communities are subject to periodic flooding from local rivers.

example, *Betula nana* and several ericaceous species) may also grow between tussocks.

Wildfire. – Occurrence of wildfires in the Interior Highlands Ecoregion is very common. Fire records indicate a range in size from less than 1 ha to greater than 82,000 ha, with an average size of 640 ha. The occurrence of fires can be related to the relatively warm and dry summer climate of interior Alaska and frequent lightning storms. Fire season is usually from June through the beginning of August.

Land Use and Settlement. – The ecoregion primarily provides resources for subsistence and recreational hunting and fishing. The highlands have historically been used by a number of Athabascan groups. Hunting for large game (for example, moose, caribou, and sheep) is supplemented by hunting for smaller mammals (such as ground squirrels). Streams supporting salmon and freshwater fish provide additional food and materials. Plants are collected for edible and medicinal purposes.

Many minerals have been mined, although most operations have ceased production. Important mining elements have included gold, silver, tin, tungsten, lead, copper, mercury, zinc, platinum, chromium, antimony, asbestos, molybdenum, and rare earth elements. Energy–related resources have included uranium and coal.

Delineation Methods. – The ecoregion boundary was delineated based on a generalized 500–m elevation contour. This elevation often, but not always, coincides with areas of "Alpine Tundra" on the map of "Major Ecosystems of Alaska." "Upland Spruce–Hardwood Forest" covers the rest of the region. Patterns on the relative CIR image generally agree with the boundary depicted on the ecoregion map. Transitional zones represent areas where upland peaks are widely scattered (approximately 10 km or farther from other peaks).

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Ferrians and Hobson (1973), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), Slaughter and Viereck (1986), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

106. INTERIOR BOTTOMLANDS

Distinctive Features. – The 103,000–km^2 ecoregion is composed of flat to nearly flat bottomlands along larger rivers of interior Alaska. The bottomlands are dotted with thaw and oxbow lakes (fig. 14). Soils are poorly drained and shallow, often over permafrost. Predominant vegetation communities include forests dominated by spruce and hardwood species, tall scrub thickets, and wetlands.

Climate. – The ecoregion has a continental climate. The bottomlands in the west receive more annual precipitation than those in the east. Annual precipitation ranges from 280 mm to 400 mm, and annual snowfall from 95 cm to 205 cm. Average daily minimum temperatures in winter range from -33°C to -26°C. Average daily maximum winter temperatures range from -22°C to -17°C. Summer temperatures have lows of about 7°C and highs of about 22°C. Summer maximum temperatures generally increase from west to east. Temperatures usually remain above freezing throughout the summer (June through August), though they may dip below freezing during this time.

Terrain. – The ecoregion is typified by flat to nearly flat bottomlands, with some inclusions of local hills. Most areas in the bottomlands have a slope gradient of less than 1°. Elevations range from 120 m in the west to 600 m in the east. Fluvial and aeolian (for example, large areas of stabilized dunes) deposits of mixed origin cover most of the region, but outwash gravel and morainal deposits occur in some areas, such as the Northway–Tanacross lowland. Permafrost is widespread, but it ranges from isolated masses to a continuous thin layer. The ecoregion is strongly associated with riparian features; meandering streams and side sloughs are prevalent. Oxbow lakes and thaw lakes are numerous. Morainal lakes occur in a few areas, where Pleistocene glaciers from the Alaska Range reached the edge of this ecoregion. The Interior Bottomlands Ecoregion was not glaciated during the Pleistocene epoch.

Soils. – Principal soils are Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, Typic Cryochrepts, and Typic Cryofluvents. Most soils formed in micaceous loess and alluvial materials. On flat areas away from the main river channels, soils are shallow over permafrost, poorly drained, and nearly always wet. On the slightly higher levees, soils are well drained and permafrost is deep or absent. Soils with permafrost are very susceptible to alteration upon disturbance of the organic mat because of the relatively warm (>-1.5°C) permafrost temperature. Organic mat disturbance, as by wildfire, can result in warmer soil temperatures and lowered permafrost tables. Soil physical properties may change, as well as hydrology, on any upland position.

Vegetation. – Needleleaf, broadleaf, and mixed forest stands occur on a variety of sites in the Interior Bottomlands Ecoregion. Tall scrub communities form thickets on floodplains. The wettest sites support a variety of wetland communities, such as low scrub bogs, wet graminoid herbaceous meadows, and wet forb herbaceous marshes and meadows.

Needleleaf forests are dominated by white spruce (*Picea glauca*), black spruce (*Picea mariana*), or a combination of the two. Closed stands of white spruce occupy young river terraces where soil drainage is good. Understory vegetation consists primarily of low and dwarf scrub, such as ericaceous species (for example, *Vaccinium vitis–idaea* and *V. uliginosum*, *Ledum groenlandicum*, and *Empetrum nigrum*) and dwarf arctic birch (*Betula nana*). Herbaceous species, such as twinflower (*Linnaea borealis*) and horsetail (*Equisetum sylvaticum* and *E. arvense*), are common. A well–developed moss layer (mainly of feathermosses, such as *Hylocomium splendens*, *Pleurozium schreberi*, and *Rhytidiadelphus triquetrus*) is typical.

Closed stands of black spruce occur on well–drained to poorly drained floodplain soils. Associated woody species include white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), American green alder (*Alnus crispa*), prickly rose (*Rosa acicularis*), willow (*Salix spp.*), Labrador–tea (*Ledum groenlandicum*), bog blueberry (*Vaccinium uliginosum*), and mountain–cranberry (*V. vitis–idaea*). The moss layer varies from patchy to continuous and generally includes *Hylocomium splendens* and *Pleurozium schreberi*. Sphagnum species may occur on wetter sites. Foliose lichens (for example, *Peltigera aphthosa* and *P. canina*) are common.

Stands codominated by white spruce and black spruce have a tall shrub understory of alder (*Alnus crispa*) and willow (*Salix bebbiana* and *S. scouleriana*). Other understory components are similar to those found in white spruce stands and black spruce stands.

Colder, wetter soils support black spruce woodlands, where the tall shrub (for example, *Alnus crispa*, *Betula glandulosa*, *Salix lanata*, *S. planifolia*, and *S. glauca*) understory is a much more important component of the ecosystem than in the closed forest stands. Ericaceous shrubs (for example, *Vaccinium uliginosum*, *V. vitis–idaea*, *Ledum decumbens*, *L. groenlandicum*, and *Empetrum nigrum*) are common, and herbaceous cover, dominated by sedges (*Carex spp.* and *Eriophorum vaginatum*) and grasses (for example, *Calamagrostis canadensis*), ranges from sparse to dense. Mosses (*Hylocomium splendens*, *Pleurozium schreberi*, and *Sphagnum spp.*) and lichens (*Nephroma arcticum*, *Cladonia spp.*, *Cladina spp.*, *Cetraria spp.*, and *Peltigera spp.*) provide continuous ground cover.

Broadleaf forests consist of closed stands of Balsam poplar (*Populus balsamifera*). The understory consists of shrubs, such as alder (*Alnus crispa* and *A. tenuifolia*), willow (*Salix spp.*), prickly rose (*Rosa acicularis*), high bushcranberry (*Viburnum edule*), and red–osier dogwood (*Cornus stolonifera*), as well as a dense herb layer of species such as northern bedstraw (*Galium boreale*), dwarf dogwood (*Cornus canadensis*), and bluebell (*Mertensia paniculata*).

Mixed forests form where paper birch codominates in stands with black spruce and white spruce, and where white spruce codominates in stands with balsam poplar.

Tall scrub communities are dominated by willow (for example, *Salix alaxensis* and *S. glauca*) or alder (*Alnus crispa* or *A. sinuata*). The understory is usually sparse, though mosses (for example, *Polytrichum spp.*, *Hylocomium splendens*, and *Drepanocladus uncinatus*) may be common. Herb cover ranges from sparse to dense, including bluejoint (*Calamagrostis canadensis*), horsetail (*Equisetum arvense*), monkshood (*Aconitum delphinifolium*), fireweed (*Epilobium latifolium* and *E. angustifolium*), bluebell (*Mertensia paniculata*), and lady fern (*Athyrium filix–femina*).

Low scrub bogs are characterized by open, low mixed shrubs and tussock–forming sedges. Resin birch (*Betula glandulosa*), dwarf arctic birch (*B. nana*), narrow–leaf Labrador–tea (*Ledum decumbens*), bog blueberry (*Vaccinium uliginosum*), mountain–cranberry (*V. vitis–idaea*), and sedge tussocks (for example, *Eriophorum vaginatum*) are the most common species. Mosses (for example, *Sphagnum spp.*, *Pleurozium schreberi*, and *Hylocomium splendens*) form a continuous mat between tussocks.

Wet graminoid herbaceous meadows are typically dominated by tall sedges (for example, *Carex aquatilis*, *C. rostrata*, *C. saxatilis*, and *C. sitchensis*). Woody plants are scarce. Mosses (for example, *Sphagnum spp.*) can be common.

Wet forb herbaceous marshes are characterized by an open cover of wetland emergent species. Horsetail (*Equisetum fluviatile*) typically dominates the communities, though buckbean (*Menyanthes trifoliata*) and marsh fivefinger (*Potentilla palustris*) are common associates. Aquatic mosses often are present.

Wet forb herbaceous meadows are dominated by non-graminoid herbaceous species, (for example, *Equisetum arvense*, *E. variegatum*, *Caltha palustris*, and *Juncus arcticus*,), though grasses and sedges may be present.

Wildfire. – Occurrence of wildfires in the Interior Bottomlands Ecoregion is very common. Fire records indicate a range in size from less than 1 ha to 325,150 ha (the largest in Kanuti Flats), with an average size of 2,260 ha. A high occurrence of lightning storms, a warm and dry summer climate, and stands of vegetation with branches low to the ground aid the ignition and spread of wildfire. Fire season generally lasts from June through the beginning of August.

Land Use and Settlement. – Most of the settlements in the Alaskan interior occur in the bottomlands because of the food sources and transportation routes provided by rivers. The ecoregion is used for subsistence and recreational hunting and fishing. Native inhabitants include several Athabascan groups (for example, Ingalik, Koyukon, Tanana, and Holikachuk). The riverine systems of the bottomlands provide salmon and other fish that are important sources for subsistence. A variety of mammals (for example, caribou, moose, beaver, and muskrat) and birds (for example, geese and ducks), drawn to the water, are also hunted for food and materials. Edible greens, roots, and berries round out the diet.

Extractable metals are found in certrain areas, such as near the confluence of the Yukon and Tanana Rivers, where

Figure 15. Water-worked basin of the Yukon Flats Ecoregion covered by numerous thaw and oxbow lakes. Annual precipitation is insufficient to maintain many lakes, which are replenished by yearly flooding of the Yukon River (center, flowing from east to west) during spring breakup of river ice.

gold and silver occur. An assortment of other metal and nonmetal resources have also been mined, but to a much smaller degree. There is some logging activity. Limited agricultural efforts have occurred along the Tanana River.

Delineation Methods. – The ecoregion boundary was based on areas where low and very low terrain roughness coincide with the distribution of the "Bottomland Spruce–Poplar Forest," "Lowland Spruce–Hardwood Forest," and "Low Brush, Muskeg–Bog" classes shown on the map "Major Ecosystems of Alaska." Transitional areas are not indicated because areas not consistent with the above criteria were not included in the ecoregion.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Drury (1956), Ferrians (1965), Gabriel and Tande (1983), Hall (1991), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Markon (1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), Shasby (unpub. mapping 1985), Talbot and Markon (1988, 1986), Talbot and others (1986), U.S. Bureau of Mines (1992a, 1992b), U.S. Fish and Wildlife Service (1987a), U.S. Geological Survey (1964, 1987a), Viereck (1989), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

107. YUKON FLATS

Distinctive Features. – The 33,000–km^2 Yukon Flats Ecoregion is a relatively flat, marshy basin floor in east central Alaska that is patterned with braided and meandering streams, numerous thaw and oxbow lakes, and meander scars (fig. 15). Surrounding the basin floor is a variable band of more undulating topography with fewer water bodies (fig. 16). In many respects, the ecoregion is similar to the Interior Bottomlands Ecoregion. However, the Yukon Flats Ecoregion differs in climatic characteristics. Temperatures in the Flats tend to be more extreme than in the Bottomlands. For example, summers in the Flats are warmer and winters are colder than in other areas of comparable latitude. The Flats also receive less annual precipitation than the Bottomlands. Forests dominated by spruce and hardwood species, tall scrub communities, and wet graminoid herbaceous communities are the predominant vegetation types.

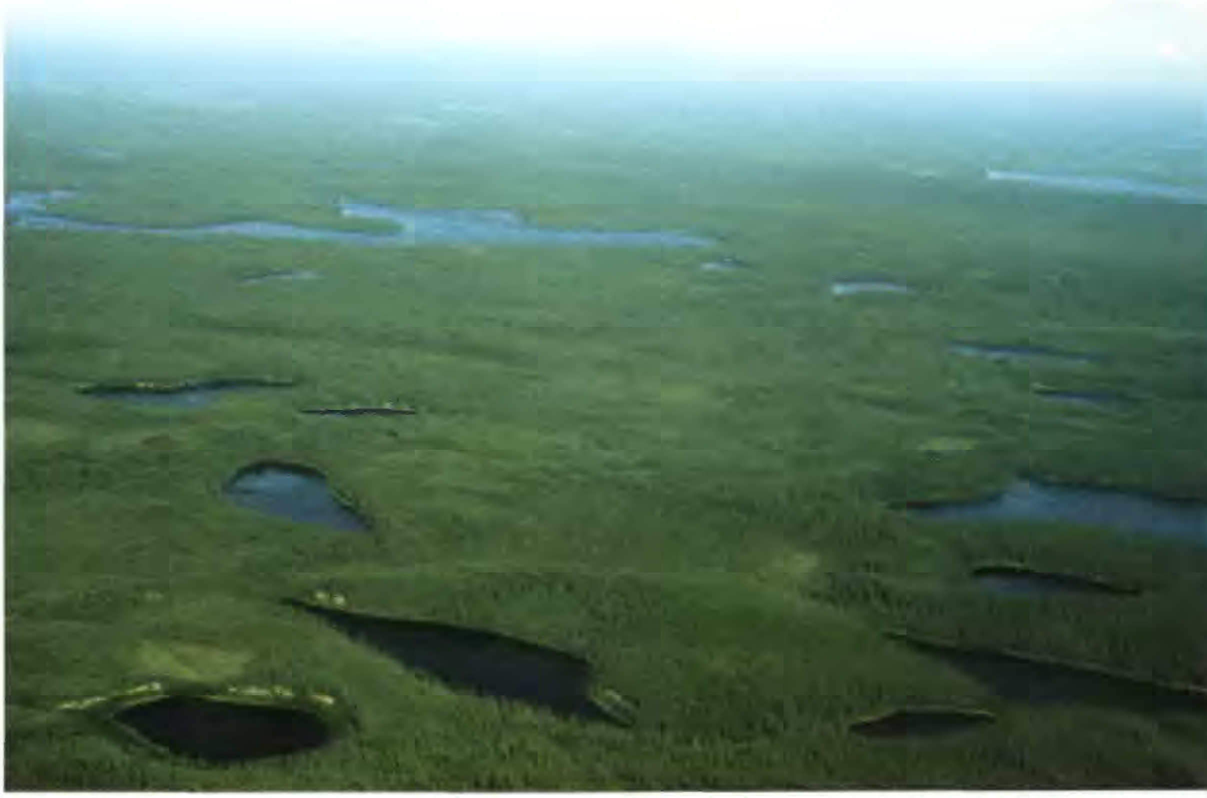

Figure 16. Undulating topography covered by dense forests of black spruce interspersed with small lakes along the periphery of the Yukon Flats Ecoregion.

Figure 17. Widespread forests of the Yukon Flats Ecoregion occupying sites representing an array of soil drainage characteristics often formed by changes in river courses. Tall scrub thickets occur on alluvial deposits subject to periodic flooding. Tall scrub swamps and wet graminoid herbaceous communities occupy the wettest sites.

Climate. – The Yukon Flats Ecoregion has a continental climate. The mountains surrounding the ecoregion isolate it from the weather systems affecting the neighboring regions. Consequently, summer temperatures tend to be higher than at other places of comparable latitude and winter temperatures tend to be colder. Average daily temperatures in winter range from lows of about -34°C to highs of about -24°C. Average daily temperatures in summer range from lows of just above freezing to highs of about 22°C (the ecoregion is the only place north of the Arctic Circle where a temperature of 38°C has been recorded). Although temperatures usually remain above freezing from June through August, freezing can occur in any month.

Annual precipitation is low, averaging 170 mm. Average annual snowfall is 115 cm. Precipitation is not sufficient to maintain water levels in many lakes. Levels are primarily maintained by the yearly flooding of the region that accompanies spring breakup of ice on the Yukon River.

Terrain. – The central portion of the ecoregion is flat, becoming more undulating along the edges. Elevations range from 90 m to greater than 250 m. Slope gradient is generally less than 1° in the center of the ecoregion, and 1° to 2° at the edges. The region is mantled by Quaternary alluvial deposits. Aeolian silt and sand deposits cover some areas. The Yukon River drains the ecoregion, assisted by numerous meandering and braided tributaries and side sloughs. Permafrost is present in most areas, except beneath rivers and large thaw lakes. Thaw lakes are abundant, as are oxbow lakes. The region was free from glaciation during the Pleistocene epoch.

Soils. – Principal soils are Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, and Pergelic Cryochrepts. Most soils formed from silty alluvium and loess from the floodplains of the large rivers. On flat areas away from the main river channels, soils are poorly drained, commonly overlain by peat, and have a shallow permafrost table. Soils on the natural levees are better drained and consist of silty and sandy sediments. Many of the soils are subject to flooding. Soils with permafrost are very susceptible to alteration upon disturbance of the organic mat, due to the relatively warm (>-1.5°C) permafrost temperature. Organic mat disturbance, as by wildfire, can result in warmer soil temperatures and lowered permafrost tables. Soil physical properties may change, as well as hydrology, on any upland position.

Vegetation. – Needleleaf, broadleaf, and mixed forests are widespread and occupy sites representing an array of soil drainage characteristics. Tall scrub thickets occur on alluvial deposits subject to periodic flooding. Tall scrub swamps and wet graminoid herbaceous communities occupy the wettest sites (fig. 17).

Needleleaf forests of white spruce (*Picea glauca*) are found on well drained sites. Willow (for example, *Salix bebbiana*) commonly dominates the understory shrub layer. Foliose lichens (for example, *Parmelia spp.* and *Peltigera spp.*), along with feathermosses, cover the ground.

Needleleaf forests dominated by black spruce (*Picea mariana*) grow in open stands where drainage is poor. Common understory shrubs are resin birch (*Betula glandulosa*), narrow–leaf Labrador–tea (*Ledum decumbens*), crowberry (*Empetrum nigrum*), and bog blueberry (*Vaccinium uliginosum*). Feathermosses are common.

Broadleaf forests dominated by quaking aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) occur on floodplains. Common understory shrubs include willow (*Salix spp.*), prickly rose (*Rosa acicularis*), and buffaloberry (*Shepherdia canadensis*).

Mixed forests consist of closed stands of white spruce and paper birch (*Betula papyrifera*) or white spruce and balsam poplar (*Populus balsamifera*) on the better drained alluvial soils; poorly drained soils support stands of black spruce (*Picea mariana*) and paper birch.

Understory constituents of the broadleaf and mixed forest communities generally include a tall shrub layer of alder (for example, *Alnus crispa* and *A. tenuifolia*) and willow (*Salix spp.*) and a low shrub layer of prickly rose (*Rosa acicularis*) and high bushcranberry (*Viburnum edule*). An herb layer is common and typically includes bluejoint (*Calamagrostis canadensis*), bluebell (*Mertensia paniculata*), and horsetail (*Equisetum spp.*).

Tall scrub communities are dominated by willows (generally *Salix alaxensis*, *S. arbusculoides*, *S. barclayi*, *S. lanata*, and S. sitchensis), alders (*Alnus crispa*, *A. sinuata*, and *A. tenuifolia*), or a mix of willows and alders. Herbs (for example, *Calamagrostis canadensis*, *Epilobium angustifolium*, *Geranium erianthum*, and *Aconitum delphinifolium*) and mosses (for example, *Hylocomium splendens*, *Polytrichum spp.*, and *Drepanocladus uncinatus*) may be abundant or sparse.

Tall scrub swamp communities are dominated or codominated by alder (*Alnus tenuifolia*) and willow (*Salix planifolia* and *S. lanata*). The low shrub layer typically includes currant (*Ribes spp.*), high bushcranberry (*Viburnum edule*), and prickly rose (*Rosa acicularis*). Bluejoint (*Calamagrostis canadensis*), sedge (*Carex aquatilis*), horsetail (*Equisetum spp.*), and marsh fivefinger (*Potentilla palustris*) are common herbs. Mosses (for example, *Sphagnum spp.*, *Mnium spp.*, and feathermosses) are usually present.

Wet graminoid herbaceous communities are dominated by sedges (for example, *Carex aquatilis*, *C. rostrata*, *C. saxatilis*, and *C. sitchensis*). Other herbaceous vegetation, such as horsetail (*Equisetum arvense*), may codominate with sedges. Mosses (for example, *Sphagnum spp.*) can be common.

Wildfire. – Occurrence of wildfires in the Yukon Flats Ecoregion is common. The recorded range in size has been from less than 1 ha to 32,370 ha. Mean fire size is 685 ha.

Land Use and Settlement. – The region is populated by several small villages. The primary land use is subsistence and recreational hunting and fishing. The Kutchin Athabascans have historically inhabited the Yukon Flats basin. They depend on the rivers to provide salmon and freshwater fish, a main dietary staple. Hunting for caribou and moose is also important, supplemented by hunting for smaller mammals. Edible and medicinal greens, roots, and berries are collected. Gold has been the only major mined commodity.

Delineation Methods. – The ecoregion boundary was based on areas where low and very low terrain roughness coincide with the "Bottomland Spruce–Poplar Forest," "Lowland Spruce–Hardwood Forest," and "Low Brush, Muskeg–Bog" classes shown on the map "Major Ecosystems of Alaska." Transitional zones separate the central core of the region, where very low terrain roughness occurs, from the peripheral, low surface roughness areas. The "core" area corresponds with patterns evident on the relative CIR image.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Fish and Wildlife Service (1987b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

108. OGILVIE MOUNTAINS

Distinctive Features. – The 11,000–km^2 Ogilvie Mountains Ecoregion, along the eastern edge of Alaska, consists of flat–topped hills eroded from a former plain (fig. 18) and broad pediment slopes built up from mountains that are much subdued from their former stature. Karst topography is common. Mesic graminoid herbaceous communities and tall scrub communities are widespread throughout the region. Forest communities occupy lower hillslopes and valleys.

Climate. – The Ogilvie Mountains have a continental climate. No perennial weather stations are located in this region. Precipitation and temperature characteristics, interpolated from stations outside the region, include an annual precipitation of about 500 mm in the hills to 650 mm in the higher mountains, annual snowfall from 130 cm to 205 cm across the region, daily winter temperatures ranging from lows of -32°C to highs of -22°C, and daily summer temperatures ranging from lows of 8°C to highs of 22°C.

Terrain. – The ecoregion consists predominantly of flat–topped hills eroded from a former plain. Pediment slopes, extending across broad valleys to the foothills of the current, subdued mountains, are characteristic of the plateaus. Erosional scarps in sedimentary rock occur in many localities. Weathered limestone is exposed at higher elevations, and talus and rubble mantle the lower mountainsides. Elevations range from 900 m to greater than 1,300 m. Slope gradients are generally less than 5°. The region is composed of metamorphic and sedimentary rocks, primarily dolomite, phyllite, argillite, limestone, shale, chert, sandstone, and conglomerate. Karst topography is common. Most of the region is underlain by permafrost; related features include pingos, earth hummocks, peat polygons, stone stripes, and beaded streams. Ponds and thermokarst basins occur in valley bottoms. The Ogilvie Mountains Ecoregion was not glaciated during the Pleistocene epoch.

Soils. – Principal soils of the Ogilvie Mountains Ecoregion are Histic Pergelic Cryaquepts, Typic Cryochrepts, and Pergelic Cryorthents. Soils formed in gravelly or stony material weathered from local rock. Soils in valleys formed from deep, loamy, alluvial sediments from the surrounding uplands. Areas near large floodplains are commonly mantled with silty loess. Rock fragments cover the lower mountainsides.

Vegetation. – Mesic graminoid herbaceous communities dominated by tussock–forming sedges are widespread and occur on sites exposed to wind. Needleleaf, broadleaf, and mixed forest communities occupy lower hillslopes and valleys. Tall scrub communities occur extensively at lower elevations and can extend above the timberline.

Mesic graminoid herbaceous communities are dominated by sedges (for example, *Eriophorum vaginatum* and *Carex bigelowii*). Mosses (for example, *Drepanocladus spp.* and *Sphagnum spp.*) commonly occur between sedge tussocks. Dwarf shrubs, such as dwarf arctic birch (*Betula nana*) and ericaceous species (for example, *Ledum decumbens*, *Vaccinium vitis–idaea*, *V. uliginosum*, and *Empetrum nigrum*), are often present.

Needleleaf forests dominated by white spruce (*Picea glauca*) occur in well drained valleys and on protected sites. The more open forest stands typically have a tall shrub layer of alder (*Alnus crispa* and *A. sinuata*) and willow (*Salix planifolia* and *S. lanata*), and a low shrub layer dominated by buffaloberry (*Shepherdia canadensis*) and prickly rose (*Rosa acicularis*). The ground supports a continuous mat of feathermosses (for example, *Pleurozium schreberi* and *Hylocomium splendens*). Closed forest stands generally lack a tall shrub layer but have a low shrub layer of bog blueberry (*Vaccinium uliginosum*), mountain–cranberry (*V. vitis–idaea*), bearberry (*Arctostaphylos rubra*), Labrador–tea (*Ledum groenlandicum*), crowberry (*Empetrum nigrum*), and resin birch (*Betula glandulosa*).

Figure 18. The Ogilvie Mountains Ecoregion consists of flat-topped hills and broad pediment slopes vegetated by tussock tundra communities, alpine shrubs, mosses, and lichens. Forest communities occupy lower hillslopes and valleys. (Photo courtesy of Ken Winterberger, Forest Service, Forestry Sciences Laboratory, Anchorage.)

Figure 19. The Subarctic Coastal Plains Ecoregion is typified by numerous lakes surrounded by wet tundra communities, resulting from a shallow permafrost table and wet soils. The climate is affected by both maritime and continental influences.

Broadleaf forests of quaking aspen (*Populus tremuloides*) and balsam poplar (*Populus balsamifera*) occupy well–drained warmer sites and recently exposed alluvial deposits. A tall shrub layer of willow (*Salix spp.*) is common. A low shrub layer generally includes prickly rose (*Rosa acicularis*) and buffaloberry (*Shepherdia canadensis*).

Mixed forests on poorly drained lowlands are dominated by black spruce (*Picea mariana*) and paper birch (*Betula papyrifera*). The understory consists of tall shrubs (for example, *Alnus crispa*, *Salix bebbiana*, and *S. scouleriana*) and low shrubs (for example, *Rosa acicularis*, *Viburnum edule*, *Ribes triste*, and *Spiraea beauverdiana*).

Mixed forests of well drained sites result from the invasion of white spruce into stands of aspen and balsam poplar (see broadleaf forest description above).

Tall scrub communities form dense thickets dominated by birch (*Betula glandulosa*) and willow (for example, *Salix alaxensis*, *S. arbusculoides*, *S. planifolia*, and *S. lanata*).

Wildfire. – Occurrence of wildfires in the Ogilvie Mountains Ecoregion is low. Size of burn ranges from less than 1 ha to 18,650 ha, with an average of 1,050 ha.

Land Use and Settlement. – There are only a few permanent settlements in this ecoregion. The region has traditionally been used for subsistence hunting and fishing by descendants of the Kutchin Athabascans. Larger streams are fished for salmon and freshwater species. Caribou, moose, and small mammals are the major terrestrial game. Edible and medicinal plants are also collected.

Gold, silver, platinum, and tin have been mined in this region, though mining is not extensive. Prospective sources of other metals and of energy–related commodities (coal, petroleum, and uranium) have been investigated.

Delineation Methods. – The ecoregion boundary was delineated using a generalized 600–m elevation contour, which somewhat corresponded with patterns shown on the relative CIR image. Information was insufficient to map transitional areas.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Oswald and Senyk (1977), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

109. SUBARCTIC COASTAL PLAINS

Distinctive Features. – The 91,000–km^2 ecoregion mainly includes coastal plains of the Kotzebue Sound area and the Yukon and Kuskokwim River delta area. Flat, lake–dotted coastal plains and river deltas are characteristic of the region (fig. 19). Streams have very wide and serpentine meanders. Soils are wet and the permafrost table is shallow, providing conditions for wet graminoid herbaceous communities, the predominant vegetation type. The region is affected by both maritime and continental climatic influences.

Climate. – Climate is transitional between maritime and continental influences. In general, the southern portion of the region has warmer temperatures and receives more precipitation than the northern portion. Average annual precipitation varies from about 250 mm around Kotzebue Sound to 500 mm in the Yukon–Kuskokwim lowlands. Annual snowfall is approximately 100 cm in the north and ranges from 105 cm to 150 cm in the south. Temperatures in winter range from average daily lows of -25°C in the north and -20°C to -15°C in the south, to average daily maximums of -16°C in the north and -10°C in the south. July and August are usually frost–free months over most of the region. Average daily minimum temperatures in summer range from 6°C in the north to a couple of degrees warmer in the south. Average summer daily maximum temperatures vary from 13°C to 17°C in both the northern and southern sections of the ecoregion, generally increasing inland from the coast.

Terrain. – The ecoregion is comprised mainly of flat, poorly drained coastal plains with shallow permafrost tables. Low hills of basalt surmounted by cinder cones and broad shallow volcanic craters occur in some locations, creating a range in regional elevation from sea level to greater than 120 m. Slope gradients in the plains are generally less than 1°. The region is predominantly covered by older coastal deposits of interstratified alluvial and marine sediments. Quaternary mafic and undifferentiated volcanic rocks occur in the western part of the Yukon–Kuskokwim lowlands and on Nunivak and St. Lawrence Islands. Cretaceous intermediate volcanic rocks occur in the Selawik Wildlife Refuge area. Only the northernmost portion of the ecoregion, around Kotzebue, was subject to Pleistocene glaciation. Continuous thin to moderately thick permafrost underlies the entire region. Thaw lakes and thaw sinks are numerous. Pingos are common around the Selawik River area. Streams are sluggish and have very wide meanders.

Soils. – Dominant soils are Histic Pergelic Cryaquepts and Pergelic Cryofibrists. Soils are shallow over permafrost and are constantly wet. Soils have formed from stratified silty and sandy alluvial deposits that, in many areas, have additionally incorporated deposits of volcanic ash and loess.

Figure 20. White and black spruce stands growing on old river meander scars in the southern portion of the Subarctic Coastal Plains Ecoregion.

Soils on Nunivak Island formed in very gravelly and stony materials derived from basaltic rock.

Vegetation. – Standing water is almost always present in this ecoregion. Wet graminoid herbaceous communities, such as wet meadows and bogs, predominate in saturated soils. Peat mounds, barren sand dunes, and volcanic soils support dwarf scrub communities dominated by ericaceous species. In areas where peat or alluvium accumulation and growing season temperatures are sufficient, as in the southern section of the ecoregion, invasion by trees is possible, and stands of needleleaf forests occur (fig. 20).

Wet meadows are typically dominated by sedges (for example, *Eriophorum angustifolium* and *Carex spp.*). Mosses (for example, *Sphagnum spp.*) are common and may codominate with sedges.

Bogs develop where peat mounds and polygonal ridges provide drained substrates for woody plants, such as ericaceous shrubs (for example, *Empetrum nigrum*, *Ledum decumbens*, *Loiseleuria procumbens*, *Vaccinium vitis–idaea*, and *Andromeda polifolia*). Sedges are common or codominant with woody species. Sphagnum species usually dominate the moss layer.

Dwarf scrub communities are typically dominated by crowberry (*Empetrum nigrum*). Many other ericaceous species (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, *Ledum decumbens*, *Loiseleuria procumbens*, and *Arctostaphylos alpina*) and dwarf willows are common in these communities. Fruticose lichens (for example, *Alectoria spp.*, *Cladina spp.*, and *Cetraria spp.*) often codominate with shrubs. Mosses (for example, *Rhacomitrium spp.*, *Hypnum spp.*, *Polytrichum spp.*, *Sphagnum spp.*, and *Dicranum spp.*) are also common.

Needleleaf forests consist of black spruce (*Picea mariana*) and white spruce (*P. glauca*). Alder (*Alnus spp.*), willow (*Salix spp.*), birch (*Betula glandulosa* and *B. nana*), and ericaceous shrubs (*Vaccinium vitis–idaea*, *Ledum decumbens*, and *Empetrum nigrum*) may be found in the understory. Mosses (for example, *Sphagnum spp.*, *Dicranum spp.*, *Hypnum spp.*, *Polytrichum spp.*, *Hylocomium splendens*, and *Pleurozium schreberi*) cover the ground.

Wildfire. – Occurrence of wildfires in the Subarctic Coastal Plains Ecoregion is low. Fires generally range in size from less than 1 ha to 4,050 ha. Mean burn size is 280 ha.

Land Use and Settlement. – Small permanent and seasonal settlements occur throughout the region, primarily adjacent to rivers or along the coast. The eastern end of Kotzebue Sound was settled by the Kotzebue Sound Inuit, who rely on small ocean mammals (for example, seals), land mammals (for example, caribou), fish (for example, pink and chum salmon), and migratory birds and their eggs as important sources of food and materials. The western end of Kotzebue Sound and the northeastern portion of Norton Sound were settled by the Bering Strait Inuit, who depend more heavily on large marine mammals (for example, beluga whale, bowhead whale, and walrus). The remainder of the ecoregion was settled by the Yup'ik. The Yup'ik of St. Lawrence Island rely on walrus as a main source of food and materials. Bowhead whales and seals are also important. The Yukon–Kuskokwim Delta Yup'ik depend primarily on salmon, but other fish, seals, beluga whales, and terrestrial mammals are also important. Migratory waterfowl and their eggs provide resources during the spring. Edible and medicinal greens and berries are collected during summer.

Though mining is not extensive in this region, gold and silver have been extracted.

Delineation Methods. – The ecoregion boundary represents the coincidence of low and very low terrain roughness and the "Wet Tundra" and "Moist Tundra" ecosystems portrayed on the map "Major Ecosystems of Alaska." In the Yukon–Kuskokwim portion, areas that are north of the Yukon River include both "Wet Tundra" and "Moist Tundra" and exclude the forests of the interior regions. South of the Yukon River, only "Wet Tundra" is included because the "Moist Tundra" grades into the adjacent Ahklun and Kilbuck Mountains Ecoregion. Transition zones eliminate "Moist Tundra" from the periphery of the Subarctic Coastal Plains Ecoregion.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Fleming (written commun., 1993), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), WeatherDisc Associates, Inc. (1990), and Wibbenmeyer and others (1982).

110. SEWARD PENINSULA

Distinctive Features. – Some of the oldest geologic formations in Alaska provide a backdrop for the 47,000–km^2, predominantly treeless Seward Peninsula Ecoregion (fig. 21). Mesic graminoid herbaceous communities and low scrub communities occupy extensive areas. The ecoregion is surrounded on three sides by water, yet this has little ameliorating effect on the climate. Winters tend to be long and harsh and summers short and cool.

Climate. – Long, severe winters are typical of this ecoregion. Overall climatic characteristics range from maritime (a narrow strip along the coast), to transitional between maritime and continental influences (most of the region), to continental (in the eastern portion). Winds are persistent and strong throughout the region. Approximately 10 weeks are frost–free each summer. All weather stations in the region are located at the lower elevations. Annual precipitation is heaviest in late summer and early fall, occurring as rain. Mean annual precipitation ranges from 250 mm to 510 mm at lower elevations, with 100 cm to 190 cm of snowfall occurring. Mean annual precipitation for the highlands, interpolated from lowland data, exceeds 1,000 mm, and snowfall may be as much as 250 cm. Average daily minimum temperature in winter ranges from -24°C to -19°C, and average daily maximum from -16°C to -11°C. Average daily minimum temperature in summer ranges from 1°C to 6°C, and maximum from 13°C to 17°C. Temperatures are generally warmer in the southern portions of the region.

Terrain. – The ecoregion has narrow strips of coastal lowlands that grade into extensive uplands of broad convex hills and flat divides. Small, isolated groups of rugged mountains occur in a few locations. Elevation ranges from sea level to 500 m for most of the region; the higher mountains climb to 1,400 m. Slope gradients are generally from 0° to 5° in the lowlands and hills, but typically from 5° to 15° in the mountains. Geologic parent materials include Paleozoic sediments and metamorphosed volcanic rocks and Precambrian volcanic rocks. Highland areas are possible Cenezoic uplifts of these formations. An extensive area of Quaternary or Tertiary volcanic rock occurs in the northeastern part of the ecoregion.

Permafrost is continuous throughout the ecoregion, ranging from a thin to a moderately thick layer. Related features, such as gelifluction lobes (fig. 22) and stone stripes on sloping areas, frost scars on low knolls, and polygons in level valley bottoms, are common. Streams draining interior basins travel through narrow canyons across broad uplands. Lowlands have numerous thaw lakes, but lakes are rare in the highlands. Except for the highest elevations, the region was unglaciated during the Pleistocene epoch.

Soils. – Predominant soils are Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Typic Cryochrepts, Pergelic Cryumbrepts, Lithic Cryorthents, and Pergelic Cryorthents. Soils are generally poorly drained and shallow over permafrost. Soils on hillslopes and ridges formed in very gravelly residual materials over weathered bedrock. Soils in valleys and on lower slopes formed mainly in colluvial and alluvial sediments.

Vegetation. – The coastal beaches, rolling hills, and mountains in this ecoregion provide a variety of climate and substrate characteristics. Mesic graminoid herbaceous communities (fig. 23) and low scrub communities occupy extensive areas on hills and lower mountain slopes. Saturated or flooded soils sustain wet graminoid herbaceous communities. Tall scrub vegetation occurs along streams and on floodplains. Ridgetops and higher elevations are barren or support dwarf scrub communities.

Mesic graminoid herbaceous communities are dominated by tussock–forming sedges. Low scrub communities result when woody species colonize the area between tussocks. Principal sedges are *Eriophorum vaginatum* and *Carex bigelowii*. Woody species include dwarf arctic birch (*Betula nana*), resin birch (*B. glandulosa*), mountain–cranberry (*Vaccinium vitis–idaea*), bog blueberry (*V. uliginosum*), diamondleaf willow (*Salix planifolia*), netleaf willow (*S. reticulata*), and crowberry (*Empetrum nigrum*). Mosses (for example, *Pleurozium schreberi*, *Hylocomium splendens*, *Aulacomnium spp.*, and *Sphagnum spp.*) are prevalent, and lichens (for example, *Cetraria cucullata*, *C. islandica*, *Cladonia spp.*, *Cladina rangiferina*, and

Figure 21. Coastal plains, rolling hills, low mountains, and lava flats of the Seward Peninsula Ecoregion. A lack of trees is noticeable across all terrain types.

Figure 22. Gelifluction lobes in the Bendeleben Mountains of the Seward Peninsula Ecoregion.

Thamnolia subuliformis) can be common.

Wet graminoid herbaceous communities consist of sedges (for example, *Carex aquatilis*, *C. lyngbyaei*, *C. rostrata*, *C. saxatilis*, *C. sitchensis*, and *Eriophorum angustifolium*) and grasses (for example, *Calamagrostis canadensis* and *Arctophila fulva*).

Tall scrub communities are dominated by willow (for example, *Salix alaxensis*, *S. glauca*, *S. planifolia*, and *S. lanata*). Birch (for example, *Betula nana*) may codominate with willow in some areas. Other woody constituents include alder (*Alnus sinuata* and *A. crispa*) and shrubby cinquefoil (*Potentilla fruticosa*). A dense herb layer may be present, typically including oxytrope (*Oxytropis spp.*), vetch (*Astragalus spp.*), dwarf fireweed (*Epilobium latifolium*), wormwood (*Artemisia spp.*), and bluejoint (*Calamagrostis canadensis*). Mosses (for example, *Polytrichum spp.*, *Hylocomium splendens*, and *Drepanocladus uncinatus*) can be abundant.

Dwarf scrub communities are composed of low shrubs, grasses, and lichens. Communities are dominated by mountain–avens (*Dryas octopetala* and *D. integrifolia*) or codominated by a combination of mountain–avens and sedge (for example, *Carex scirpoidea*, *C. misandra*, and *C. bigelowii*) or mountain–avens and lichens (for example, *Alectoria spp.*, *Cetraria spp.*, and *Cladina spp.*). Other typical shrubs occurring in these communities are willows (*Salix reticulata* and *S. phlebophylla*) and ericads (for example, *Cassiope tetragona*, *Empetrum nigrum*, *Arctostaphylos spp.*, *Vaccinium vitis–idaea*, and *V. uliginosum*). Mosses (for example, *Tomenthypnum nitens*, *Rhytidium rugosum*, and *Hylocomium splendens*) can be common.

Wildfire. – Occurrence of wildfires in the Seward Peninsula Ecoregion is common. Burns range in size from less than 1 ha to 109,260 ha, with an average size of 2,815 ha. Mosses and lichens dry out during summer, allowing fire to spread readily through the tundra. Fire season is usually from June through August.

Land Use and Settlement. – Population is low and small settlements are scattered throughout the region. The land has been historically used for subsistence hunting and fishing by the Bering Strait Inuit. Their livelihood has depended on large marine mammals, such as bowhead whales, beluga whales, and walrus. Winter ice fishing and seal hunting are important to supplement spring and summer ocean catches. Away from the coast, streams provide salmon and freshwater fish. Large game (for example, caribou) and smaller mammals (for example, rabbits, squirrels, muskrats, and beaver) are also taken. Reindeer herding is unique to this area.

A number of metallic elements, including antimony, barium, gold, lead, silver, tin, tungsten, and zinc occur in the region. Numerous mines, including many gold mines, are scattered throughout large parts of the region. Other important metals include copper, mercury, platinum, and uranium. Antimony, bismuth, and coal have also been mined.

Delineation Methods. – The ecoregion boundary delineates a break between the forested ecosystems of interior Alaska and the nonforested peninsula. One of the characteristic features of the Seward Peninsula is the age of the bedrock geologic formations; the transitional area on the ecoregion map excludes the more recent geologic formations along the eastern portion of the ecoregion from the older formations throughout the core of the region.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Pittman (1992), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

111. AHKLUN AND KILBUCK MOUNTAINS

Distinctive Features. – Located in southwestern Alaska off Bristol and Kuskokwim Bays, the 51,000–km^2 ecoregion is composed of steep, sharp, often ringlike groupings of rugged mountains separated by broad, flat valleys and lowlands (fig. 24). The mountains were glaciated during the Pleistocene epoch, but only a few small glaciers persist. Dwarf scrub communities are the predominant vegetation cover in the mountains. Tall scrub and graminoid herbaceous communities are common in valleys and on lower mountain slopes. Valley bottoms may support stands of spruce and hardwood species.

Climate. – Climate is affected by both maritime and continental influences. Average annual precipitation ranges from 1,020 mm in the lowlands to 2,030 mm in the higher mountains. Average annual snowfall ranges from 205 cm to 510 cm, with a similar distribution pattern. Winter temperatures have an average daily minimum of -16°C and a maximum of -8°C. Mean summer temperatures have daily lows averaging about 8°C and daily highs of about 16°C to 19°C.

Terrain. – This mountainous ecoregion is composed of strongly deformed sedimentary and volcanic rocks of late Paleozoic and Mesozoic age and includes some bodies of older schist. Ringlike mountain groupings have resulted from small granitic masses surrounded by more resistant hornfels. Slope gradients over most of the region are from 0° to 8°, but steeper slopes are not uncommon (occurring across 7 percent of the area), and summits are very steep and

Figure 23. Mesic graminoid herbaceous communities often occupy hills and lower mountain slopes of the Seward Peninsula Ecoregion.

Figure 24. Typical sharp mountain ridges encircling glacial lakes of the Ahklun and Kilbuck Mountains Ecoregion. Mountain groupings are separated by broad valleys.

Figure 25. Ericaceous dwarf scrub-graminoid community of the Ahklun and Kilbuck Mountains Ecoregion. Prostrate dwarf scrub-lichen vegetation grows on the hilltop in the background. (Photo taken by Carl Markon, Hughes STX Corporation, U.S. Geological Survey, EROS Alaska Field Office, Anchorage.)

sharp. Broad lowlands separate mountain groups. Regional elevations rise from sea level to more than 1,500 m. Streams are generally shallow and have radial drainage patterns; most are incised in bedrock gorges. A number of long, narrow, and often deep glacial lakes have formed in U–shaped valleys. The region was heavily glaciated during the Pleistocene epoch, and a few small cirque glaciers persist on higher mountains. Permafrost is discontinuous at higher elevations, and isolated masses occur at lower elevations.

Soils. – Principal soils are Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Typic Cryochrepts, Lithic Cryumbrepts, Pergelic Cryumbrepts, Pergelic Cryorthods, Typic Haplocryods, and Typic Humicryods. Mountain soils formed in very stony and gravelly colluvial material over bedrock. Valleys soils formed in glacial till.

Vegetation. – Upper slopes and summits of mountains are exposed to harsh climatic conditions. Lower slopes and valleys offer more protected sites for vegetation establishment. Dwarf scrub communities are widespread in the mountains (fig. 25). Valleys provide an array of soil drainage conditions that support different vegetation communities (fig. 26). Sites with better drainage support needleleaf, broadleaf and mixed forest stands, and tall scrub communities. Mesic graminoid herbaceous communities occur over a range of dry to wet soils. The wettest sites are colonized by low scrub communities and wet graminoid herbaceous communities.

Dwarf scrub communities are dominated either by ericaceous shrubs (for example, *Arctostaphylos alpina*, *Vaccinium vitis–idaea*, *V. uliginosum*, *Empetrum nigrum*, and *Ledum decumbens*), or by a mix of mountain–avens (*Dryas octopetala*) and dwarf arctic birch (*Betula nana*). Lichens (for example, *Cladina spp.*, *Cetraria spp.*, *Stereocaulon tomentosum*, *Thamnolia vermicularis*, *Cladonia spp.*, and *Alectoria spp.*) may be sparse or may codominate with shrubs.

Valley bottoms may support needleleaf forests dominated by white spruce, broadleaf forests dominated by balsam poplar (*Populus balsamifera*), or mixed forests of white spruce and paper birch (*Betula papyrifera*). White spruce forests are dominated by *Picea glauca*. Resin birch (*Betula glandulosa*) dominates the low shrub layer. Common herbs include *Linnaea borealis*, *Calamagrostis canadensis*, and *Equisetum spp.* A nearly continuous cover of feathermosses (for example, *Pleurozium schreberi* and *Hylocomium splendens*) is typical. Lichens (for example, *Cladonia spp.*) are particularly common in open areas.

Balsam poplar forests are dominated by *Populus balsamifera* in the overstory. Understory composition varies, usually including willow (*Salix spp.*), alder (*Alnus spp.*), high bushcranberry (*Viburnum edule*), prickly rose (*Rosa acicularis*), bluejoint (*Calamagrostis canadensis*), and feathermosses (*Hylocomium splendens* and *Pleurozium schreberi*).

Spruce–paper birch forests are dominated by white spruce (*Picea glauca*) and paper birch (*Betula papyrifera*). Shrubs, such as willow (*Salix bebbiana* and *S. scouleriana*), alder (*Alnus crispa*), prickly rose (*Rosa acicularis*), and high bushcranberry (*Viburnum edule*), are common. Typical herbs are bluejoint (*Calamagrostis canadensis*) and horsetail (*Equisetum arvense*). Cover by mosses (for example, *Hylocomium splendens*, *Dicranum spp.*, *Hypnum spp.*, and *Rhacomitrium spp.*) is patchy.

Tall scrub communities are dominated by willow (for example, *Salix alaxensis*, *S. planifolia*, and *S. glauca*), alder (for example, *Alnus crispa* and *A. sinuata*), or a mix of ericaceous shrubs (for example, *Empetrum nigrum*, *Ledum decumbens*, *Vaccinium vitis–idaea*, *V. uliginosum*, and *Arctostaphylos alpina*), dwarf arctic birch (*Betula nana*), and sedges (for example, *Carex spp.*). Mosses (for example, *Hypnum spp.*, *Dicranum spp.*, and *Polytrichum spp.*) may be common or absent.

Figure 26. Vegetation communities showing patterns related to slope position and drainage characteristics in the Ahklun and Kilbuck Mountains Ecoregion. Low scrub communities grow in drainage tracks. Dwarf scrub-lichen communities grow on better drained sites that are more exposed to wind, such as on the tops of lower rounded summits and at middle and upper slopes. Low and dwarf scrub communities occur in open, low, flat areas.

Figure 27. Subtly rolling terrain of the Bristol Bay-Nushagak Lowlands Ecoregion. The region has better drainage than other coastal lowlands.

Mesic graminoid herbaceous communities are dominated by bluejoint (*Calamagrostis canadensis*), which forms meadows that may include other herbaceous species (for example, *Carex spp.*, *Eriophorum spp.*, and *Epilobium angustifolium*).

Low scrub communities include low scrub–sedge tussock bogs, ericaceous scrub bogs, and low sweetgale–graminoid bogs. Low scrub–sedge tussock bogs are codominated by low woody plants (for example, *Betula glandulosa*, *B. nana*, and *Vaccinium vitis–idaea*) and tussock–forming sedges (for example, *Eriophorum vaginatum*). Mosses (for example, *Sphagnum spp.* and *Rhacomitrium spp.*) provide a nearly continuous mat between tussocks.

Ericaceous scrub bogs are dominated by *Empetrum nigrum*, *Vaccinium vitis–idaea*, *V. uliginosum*, *V. oxycoccus*, and *Ledum decumbens*. Sedges (for example, *Carex spp.* and *Trichophorum caespitosum*) are common or codominant. The moss layer is usually dominated by *Sphagnum* species, though other species (for example, *Dicranum spp.*) may be common. Lichens (for example, *Cladina spp.*) are present on mounds.

Sweetgale–graminoid bogs are dominated by sweetgale (*Myrica gale*), bluejoint (*Calamagrostis canadensis*), sedges (*Carex spp.*), and clubrush (*Trichophorum caespitosum*). Other woody and herbaceous species may be present. Mosses (for example, *Sphagnum spp.*, *Rhacomitrium spp.*, and *Hypnum spp.*) are abundant.

Wet graminoid herbaceous communities include sedge wet meadows and sedge–moss bogs. Several species of sedge (for example, *Carex aquatilis* and *C. lyngbyaei*) dominate sedge wet meadows. Sedge–moss bogs are dominated by mosses (principally *Sphagnum spp.*) and low sedges (for example, *Eriophorum russeolum*, *Carex spp.*, and *Trichophorum caespitosum*).

Wildfire. – Occurrence of wildfires in the Ahklun and Kilbuck Mountains Ecoregion is very low. Recorded burns have ranged in size from less than 1 ha to 80 ha, averaging about 20 ha.

Land Use and Settlement. – Permanent settlements are limited to the coastal margins of the ecoregion. The region has traditionally provided hunting and fishing resources to the people of the Bristol Bay and Yukon–Kuskokwim Delta Yup'ik groups. Their primary resources for subsistence have been salmon and freshwater fish, seals, and beluga whales. Terrestrial mammals, particularly caribou, provide a secondary resource. Migratory waterfowl and their eggs are an important source of food in early spring. Edible and medicinal plants are collected. Gold, silver, platinum, lead, mercury, zinc, and borax have all been mined in this ecoregion.

Delineation Methods. – The ecoregion boundary outlines a group of mountains that exceed 600 m in elevation, with some adjustment in order to include areas shown as "Moist Tundra," "Alpine Tundra," "Upland Spruce–Hardwood Forest," and "High Brush" on the map "Major Ecosystems of Alaska." These latter two ecosystem types are considered transitional with adjacent regions. Also transitional are areas of very low terrain roughness on the west side and of low and very low terrain roughness on the east side. Excluded from the Ahklun and Kilbuck Mountains Ecoregion are areas of "Lowland Spruce–Hardwood Forest" and "Wet Tundra."

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), WeatherDisc Associates, Inc. (1990), and Wibbenmeyer and others (1982).

112. BRISTOL BAY–NUSHAGAK LOWLANDS

Distinctive Features. – This 61,000–km^2 lowland ecoregion is located in southwestern Alaska off Bristol Bay. The region has rolling terrain, formed from morainal deposits (fig. 27). Soils of the lowlands are somewhat better drained than soils of the Subarctic Coastal Plains Ecoregion. Dwarf scrub communities are widespread, but large areas of wetland communities occur. Lakes are scattered throughout the lowlands, but are not nearly as numerous as in the Subarctic Coastal Plains.

Climate. – Climate is transitional between maritime and continental influences. Average annual precipitation varies greatly from location to location, ranging from 330 mm to 860 mm, with contributions from annual snowfall ranging from 75 cm to 250 cm. There is less geographic variation in temperatures. Daily winter low temperatures average -15°C in the Nushagak Lowlands and -10°C along the Alaska Peninsula. Daily winter highs average near freezing throughout the region. Daily summer low temperatures average just above freezing, and highs average about 18°C.

Terrain. – The Bristol Bay–Nushagak Lowlands Ecoregion consists of rolling lowlands, with elevations ranging from sea level to 150 m and slope gradients of generally less than 2°. The region was glaciated during the Pleistocene epoch and is covered by glacial moraine and outwash. Deposits tend to be coarse near the mountains of adjacent ecoregions, grading to fine sand along the coast. Sand dunes are found along sea bluffs, river bluffs, and past and current shorelines of larger lakes. Parts of the lowlands are mantled by silt and peat. Most streams arise from nearby mountainous ecoregions, and many are headwatered in lakes in ice–carved basins. The lowland is dotted with morainal and thaw lakes. Isolated masses of permafrost occur in the Nushagak Lowland area. The southern half of the region is generally free from permafrost.

Soils. – Dominant soils are Typic Haplocryands, Typic Vitricryands, Fluvaquentic Cryofibrists, Histic Pergelic Cryaquepts, Pergelic Cryaquepts, and Typic Cryochrepts. Most soils formed in volcanic ash deposits of various thickness underlain by gravelly glacial till, outwash deposits, or silty alluvium. Coastal plain soils formed in gravelly alluvium, cinders, or weathered rock blanketed with thick sedge peat.

Vegetation. – Dwarf scrub communities grow on relatively well drained mineral soils and are the dominant vegetation type in this ecoregion (fig. 28). Wetland communities vegetate large areas; poorly drained slopes and terraces are colonized by low scrub bog communities, and poorly drained lowlands are colonized by wet graminoid herbaceous communities and wet forb herbaceous communities. Of more limited distribution are broadleaf and mixed forest stands that grow on the floodplains of major rivers.

Dwarf scrub communities are dominated by ericaceous species (typically *Empetrum nigrum*). Lichens (for example, *Alectoria spp.*, *Cetraria spp.*, and *Cladonia spp.*) may be codominant. A number of other woody species (for example, *Ledum decumbens*, *Loiseleuria procumbens*, *Arctostaphylos alpina*, *Salix spp.*, and *Dryas octopetala*) may be present. Mosses (for example, *Sphagnum spp.* and *Dicranum spp.*) are common in most stands. Dwarf arctic birch (*Betula nana*) may invade these communities when peat accumulation provides a deeper rooting zone.

Low scrub bog communities are codominated by woody species (for example, *Betula glandulosa*, *B. nana*, *Ledum decumbens*, *Vaccinium vitis–idaea*, *V. uliginosum*, and *Empetrum nigrum*) and tussock–forming sedges (for example, *Eriophorum vaginatum*). Mosses (primarily *Sphagnum spp.*) form a nearly continuous mat.

Wet graminoid herbaceous communities include fresh sedge marshes, wet sedge meadows, sedge–moss bog meadows, and halophytic sedge wet meadows. Fresh sedge marshes are comprised almost entirely of tall emergent sedges (for example, *Scirpus validus* or *Eleocharis palustris*). As plant detritus and sediments accumulate, these communities may be replaced by wet sedge meadows dominated by *Carex* species. Mosses (for example, *Dicranum spp.*, *Polytrichum spp.*, and *Sphagnum spp.*) may be abundant in meadows.

Sedge–moss bog meadows occur in peat–filled depressions. Low sedges (for example, *Eriophorum russeolum*, *Carex spp.*, and *Trichophorum caespitosum*) are dominant and are rooted along with other herbs (for example, *Potentilla palustris*) in a mat of sphagnum mosses.

Halophytic sedge wet meadows occur in coastal areas and are dominated by *Carex lyngbyaei*. Other important graminoid constituents include *Eriophorum spp.* and *Calamagrostis canadensis*.

Wet forb herbaceous communities mainly include fresh herb marshes colonized principally by emergent herbs (for example, *Menyanthes trifoliata*, *Potentilla palustris*, and *Equisetum fluviatile*). Aquatic mosses (for example, *Sphagnum spp.*) are common.

Broadleaf forest communities are dominated by birch (*Betula papyrifera*) or codominated by birch and other tree species (for example, *Populus balsamifera*). A tall shrub understory is common, consisting of willow (for example, *Salix bebbiana* and *S. scouleriana*) and alder (*Alnus crispa* and *A. sinuata*). A low shrub understory typically includes prickly rose (*Rosa acicularis*), high bushcranberry (*Viburnum edule*), and resin birch (*Betula glandulosa*). Dwarf dogwood (*Cornus canadensis*) and fireweed (*Epilobium angustifolium*) are common forbs. Mixed forest communities result where white spruce (*Picea glauca*) codominates with birch.

Wildfire. – Occurrence of wildfires in the Nushagak Lowlands portion of the ecoregion is low. The range in recorded burn size is from less than 1 ha to 1,820 ha, averaging 870 ha. Fire data are not available for the portion of the ecoregion along the Alaska Peninsula.

Land Use and Settlement. – Permanent settlements occur primarily along the coast or adjacent to the larger rivers. The region is used primarily for commercial fishing and processing and for subsistence and recreational hunting and fishing. The northern half of the region was settled by the Bristol Bay Yup'ik, and the southern half was settled by the Koniag. These two groups are descended from the Bering Sea Yup'ik and the Pacific Yup'ik, respectively. Coastal communities rely primarily on marine resources (for example, whales, seals, salmon, halibut, sea lions, sea otters, clams, mussels, and seaweed). Away from the coast, salmon and terrestrial mammals (for example, caribou and moose) are more important. Edible and medicinal greens, roots, and berries are also collected.

Delineation Methods. – The ecoregion boundary is generally based on inclusion of the "Moist Tundra," "Wet Tundra," and "Lowland Spruce–Hardwood Forest" ecosystems and an exclusion of "High Brush," "Alpine Tundra," and "Upland Spruce–Hardwood Forest" ecosystems, as depicted on the map "Major Ecosystems of Alaska." Transitional zones occur where "Upland Spruce–Hardwood Forest" penetrates from the Ahklun and Kilbuck Mountains Ecoregion to the west, and in areas having moderate to high terrain roughness, as shown on the terrain roughness map.

References. – The information provided in this regional description has been compiled from Beikman (1980),

Figure 28. Distribution of vegetation communities indicates a relationship with hillslope position and drainage characteristics in the Bristol Bay-Nushagak Lowlands Ecoregion. Dwarf shrubs, graminoid species, and lichens grow in well drained areas. Scattered small communities of alder occur on hillslopes. Graminoid marsh communities grow in depressions.

Figure 29. Alaska Peninsula Mountains Ecoregion typically shrouded in clouds. Soils, formed from volcanic ash and cinder, are highly erodible and restrict the development of vegetation.

Black (1951), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), WeatherDisc Associates, Inc. (1990), and Wibbenmeyer and others (1982).

113. ALASKA PENINSULA MOUNTAINS

Distinctive Features. – The 48,000–km^2 ecoregion is composed of rounded, folded and faulted sedimentary ridges intermittently surmounted by volcanoes. The mountains were heavily glaciated during the Pleistocene epoch. A maritime climate prevails, and the region is generally free of permafrost. Many soils formed in deposits of volcanic ash and cinder over glacial deposits and are highly erodible (fig. 29). Vegetation cover commonly consists of dwarf scrub communities at higher elevations and on sites exposed to wind, and low scrub communities at lower elevations and in more protected sites.

Climate. – Climate has a predominantly maritime influence, as is evident from the higher precipitation and lower seasonal and diurnal fluctuations in air temperatures than in ecoregions having continental or transitional climates. Annual precipitation varies greatly from location to location along the coast, with coastal areas receiving from 600 mm to 3,300 mm. High elevations in the mountains average more than 4,060 mm of precipitation each year. Mean annual snowfall ranges from 55 cm to 150 cm along the coast and exceeds 510 cm in the higher mountains. Winter daily minimum temperatures average from -11°C to -6°C throughout the region; daily maximum temperatures average from -2°C to 1°C. Summer temperatures range from lows of about 6°C to highs of about 15°C.

Terrain. – The region is characterized by rounded ridges, 300 m to 1,200 m high, surmounted at varying intervals by rugged volcanic peaks, 1,400 m to 2,600 m high. The mountains are dissected by many drainageways. Slope gradients are usually from 0° to 11°, but steeper slopes occur across 7 percent of the region. Geological formations consist of stratified Jurassic, Cretaceous, and Tertiary sediments, and undifferentiated Quaternary volcanic rocks. The region was heavily glaciated during the Pleistocene epoch. Most of the volcanoes reached their acme following Pleistocene glaciation. Glaciers persist on volcanoes. Many features of glacial erosion are present, such as cirques and U–shaped valleys. The ecoregion is generally free from permafrost.

Streams draining to the Pacific Ocean are short and have steep gradients. Streams draining to the Bering Sea become braided when they reach the rolling lowlands of the Bristol Bay–Nushagak Lowlands Ecoregion to the north. Many streams are glacier fed. Lakes have been formed by moraines, or have formed in ice–carved basins.

Soils. – Dominant soils are Typic Haplocryands and Typic Vitricryands. Glacial deposits cover all but the highest parts of ridges. Soils, formed in deposits of volcanic ash and cinder that mantle the glacial deposits, are highly erodible. Mountain peaks, rock escarpments, and talus slopes have little or no soil cover. Some depressions are filled with fibrous peat.

Vegetation. – Dwarf scrub communities are widespread in this ecoregion, occurring at higher elevations and on windswept areas (fig. 30). Low scrub communities grow on sites more protected from wind and at lower elevations. Tall scrub communities grow at lower elevations and along hillslope drainages. Floodplains and south–facing slopes support broadleaf forest stands. Poorly drained areas are colonized by low scrub bog communities and mesic graminoid herbaceous communities.

Dwarf scrub communities are generally dominated by crowberry (*Empetrum nigrum*). Accompanying shrubs include other ericads (for example, *Vaccinium vitis–idäea*, *V. uliginosum*, and *Arctostaphylos alpina*), arctic willow (*Salix arctica*), and white mountain–avens (*Dryas octopetala*). Mosses (for example, *Dicranum spp.*, *Hypnum spp.*, *Polytrichum spp.*, and *Rhacomitrium spp.*) and lichens (for example, *Alectoria spp.*, *Cladonia spp.*, *Cladina spp.*, and *Cetraria spp.*) are common.

Low scrub communities are dominated by willow (for example, *Salix glauca*, *S. lanata*, and *S. planifolia*). Dwarf shrubs (for example, *Betula nana*, *Vaccinium vitis–idaea*, *V. uliginosum*, *Ledum decumbens*, *Dryas spp.*, and *Salix reticulata*) and forbs (for example, *Calamagrostis canadensis*, *Festuca altaica*, *Carex bigelowii*, and *Artemisia spp.*) colonize the understory. Mosses (for example, *Polytrichum spp.* and *Hypnum spp.*) form a patchy to continuous mat cover.

Tall scrub communities consist primarily of alder (for example, *Alnus sinuata*) or a mix of alder and willow (*Salix alaxensis*, *S. barclayi*, *S. planifolia*, and *S. glauca*). Low shrubs (for example, *Betula glandulosa*, *B. nana*, *Vaccinium vitis–idaea*, *V. uliginosum*, and *Ledum decumbens*) may be common or absent in the understory.

Broadleaf forests are dominated by balsam poplar (*Populus balsamifera*). A tall shrub understory of alder and willow is usually present. Bluejoint (*Calamagrostis canadensis*) is important in the herbaceous layer. Mosses (commonly feathermoss species) provide extensive ground cover.

Low scrub bogs are typically dominated by ericaceous species, such as crowberry (*Empetrum nigrum*), narrow–leaf Labrador–tea (*Ledum decumbens*), mountain–cranberry (*Vaccinium vitis–idaea*), bog blueberry (*V. uliginosum*), and bog cranberry (*V. oxycoccus*). Sedges (for example,

Figure 30. Dwarf scrub communities are common on the middle slopes and some of the higher slopes of the Alaska Peninsula Mountains Ecoregion. Willow grows along the lower slopes. The beach ridges along the shore are vegetated by willow and alder. (Photo courtesy of Keith Trexler, National Park Service, Anchorage.)

Figure 31. Typical landscape of the Aleutian Islands Ecoregion, composed of a chain of sedimentary islands overtopped by steep volcanoes. Bare rock and rubble occur on volcanic cones, peaks, and high ridgetops. Dwarf shrub tundra communities occur at higher elevations and in windswept areas. Moist tundra communities are found at lower elevations and in protected sites. (Photo courtesy of Leslie Kerr, Fish and Wildlife Service, Anchorage.)

Eriophorum spp. and *Carex spp.*) and forbs (for example, *Potentilla palustris* and *Menyanthes trifoliata*) are common. Sphagnum mosses are always present and are usually the dominant mosses. Lichens (for example, *Cladina spp.* and *Cetraria spp.*) occur on mounds.

Mesic graminoid herbaceous communities primarily consist of meadows dominated by bluejoint (*Calamagrostis canadensis*) or a mix of bluejoint and various herbs (for example, *Epilobium angustifolium*, *Heracleum lanatum*, *Athyrium filix–femina*, and *Equisetum arvense*).

Wildfire. – No fire data are available for the Alaska Peninsula.

Land Use and Settlement. – Settlements are located mainly along the coastline. The region is used primarily for commercial fishing and processing and for subsistence and recreational hunting and fishing. The area was historically occupied by the Koniag, of the Pacific Yup'ik people. Marine resources, such as whales, seals, salmon, halibut, cod, rockfish, sea lions, sea otters, porpoises, shellfish, sea urchins, bivalves, and seaweed, have been the basis for subsistence. Terrestrial mammals (for example, caribou, moose, ground squirrel, and hare) are of secondary importance. Plant greens, roots, and berries are collected for food and medicinal purposes.

Several metals have been mined in this ecoregion, including gold, silver, lead, and copper. Energy–related resources, such as coal and petroleum, have also been extracted.

Delineation Methods. – The boundary separating the Alaska Peninsula Mountains from the Bristol Bay–Nushagak Lowlands is based on the inclusion of "Alpine Tundra" and "High Brush" ecosystems and on the exclusion of "Moist Tundra" and "Wet Tundra" ecosystems, as shown on the map "Major Ecosystems of Alaska." The boundary separating the Alaska Peninsula Mountains from the Aleutian Islands is based on general climate information; the exact placement of the line is somewhat arbitrary. Because the Alaska Peninsula Mountains Ecoregion is narrow and environmental gradients are steep, it is not possible to delineate transitional areas at the current scale of mapping.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), WeatherDisc Associates, Inc. (1990), and Wibbenmeyer and others (1982).

114. ALEUTIAN ISLANDS

Distinctive Features. – The 12,000 km^2 Aleutian Islands Ecoregion in southwestern Alaska is composed of a chain of sedimentary islands (eroded from older volcanic formations) that are crowned by steep volcanoes (fig. 31). Maritime climate prevails. The region is south of the winter sea ice pack and is generally free from permafrost. Vegetation cover mainly consists of dwarf scrub communities at higher elevations and on sites exposed to wind, and of graminoid herbaceous communities in more protected sites.

Climate. – The Aleutian Islands have a maritime climate. Annual precipitation varies greatly from place to place, from as little as 530 mm to as much as 2,080 mm at sea level weather stations. Annual snowfall averages from 85 cm to 250 cm at the same stations. In general, smaller islands receive less precipitation than larger islands. Winter daily low temperatures average from -7°C to -2°C, and daily highs average from 2°C to 5°C. Summer daily temperatures average from lows of 4°C to highs of 10°C to 13°C. The frost–free season usually lasts from May through mid–September.

Terrain. – The ecoregion is composed of a chain of islands exposed along the crest of a submarine ridge. Most of the islands, formed of blockfaulted Tertiary sediments derived from earlier igneous processes, are surmounted by volcanoes of Tertiary and Quaternary Age. Regional elevations range from sea level to greater than 1,900 m. Most high volcanoes have icecaps or small glaciers. Lowlands have slope gradients less than 1°, but mountains are steep, with gradients almost always greater than 5°. The islands have been intensely glaciated (though only the easternmost portion was glaciated during the Pleistocene epoch), and evidence of glacial erosion is common. The region is generally free from permafrost, but periglacial erosional processes are active because of the cold, wet climate.

Streams are short and swift. Many enter the sea as waterfalls. In areas of porous volcanic rock, stream courses are widely spaced and are filled with water only during exceptionally heavy rains. Many small lakes occupy irregular ice–carved basins in rolling topography on the glaciated islands. Lakes fill a few volcanic craters and calderas.

Soils. – Dominant soils are Typic Haplocryands and Typic Vitricryands. Most soils formed in deposits of volcanic ash or cinders over basaltic bedrock. Bare rock and rubble occur on volcanic cones, peaks, and high ridgetops. Volcanic material generally grades from coarse to fine with increasing distance from active volcanoes. Organic soils occupy depressions and some broad valley bottoms.

Vegetation. – Vegetation cover at higher elevations and on windswept areas consists of dwarf scrub communities dominated by willow or crowberry. Mesic graminoid herba-

Figure 32. Spruce-hardwood forests, the most widespread vegetation community of the Cook Inlet Ecoregion. The area has one of the mildest climates in Alaska and, consequently, is generally free from permafrost.

Figure 33. Forest stand with pockets of white spruce or white spruce mixed with birch in the Cook Inlet Ecoregion.

ceous and dry graminoid herbaceous communities occur at lower elevations and in protected sites. Low scrub communities grow in bogs having thick peat deposits.

Willow dwarf scrub communities are dominated by *Salix arctica*, *S. rotundifolia*, and *S. ovalifolia*. Other common shrubs are crowberry (*Empetrum nigrum*), mountain–cranberry (*Vaccinium vitis–idaea*), bog blueberry (*V. uliginosum*), mountain–avens (*Dryas spp.*), cassiope (*Cassiope lycopodioides*), and narrow–leaf Labrador–tea (*Ledum decumbens*). Herbs, (for example, *Carex spp.* and *Saxifraga spp.*) and mosses (for example, *Dicranum spp.* and *Aulacomnium spp.*) are common.

Crowberry dwarf scrub communities are dominated by *Empetrum nigrum*. Aleutian mountain–heath (*Phyllodoce aleutica*), cassiope (*Cassiope stelleriana*), dwarf blueberry (*Vaccinium caespitosum*), and meadow–spirea (*Luetkea pectinata*) are typical constituents of these communities. Mosses are common. Lichens (for example, *Cladonia spp.*) are common in many stands.

Mesic graminoid herbaceous communities primarily consist of meadows, where bluejoint (*Calamagrostis canadensis*) is codominant with a variety of other herbs (for example, *Epilobium angustifolium*, *Equisetum arvense*, *Carex spp.*, and *Festuca spp.*).

Dry graminoid herbaceous communities occur in coastal areas, such as near coastal marshes and at the bases of cliffs. Hair–grasses (*Deschampsia spp.*) provide nearly all of the vegetation cover.

Low scrub bog communities are dominated by ericaceous species (for example, *Empetrum nigrum*, *Vaccinium uliginosum*, *V. vitis–idaea*, *V. oxycoccus*, *Andromeda polifolia*, and *Ledum decumbens*). Sedges (for example, *Eriophorum angustifolium*, *Trichophorum caespitosum*, *Carex pluriflora*, and *C. pauciflora*) are common or codominant. *Sphagnum* species are always present and are usually the dominant mosses. Feathermosses may be common. Lichens may occur on mounds.

Wildfire. – No fire data are available for the Aleutian Islands.

Land Use and Settlement. – Settlements are sparse and are primarily located along the coastline. The native populations of the islands are Aleut. They depend on marine resources (for example, Steller sea lions, seals, otters, and whales) for subsistence. Caribou and salmon are important sources of food and materials in the eastern part of the region. Tidal waters provide additional resources, such as algae, chitons, fish, mussels, urchins, octopus, and sea otters. Birds (for example, cormorants, gulls, murres, and puffins) and their eggs augment the traditional diet. Edible and medicinal plants are also collected.

Delineation Methods. – The ecoregion boundary separates the islands of the Aleutian chain from those immediately south and west of the Alaska Peninsula. The boundary is based primarily on climate information. A lack of sufficient information detail prohibits the delineation of transitional areas.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

115. COOK INLET

Distinctive Features. – Located in the south central part of Alaska adjacent to the Cook Inlet, the 28,000–km^2 ecoregion has one of the mildest climates in the State. The climate, the level to rolling topography, and the coastal proximity have attracted most of the settlement and development in Alaska. The region has a variety of vegetation communities (fig. 32) but is dominated by stands of spruce and hardwood species. The area is generally free from permafrost. Unlike many of the other nonmontane ecoregions, the Cook Inlet Ecoregion was intensely glaciated during the Pleistocene epoch.

Climate. – The climate is affected by both maritime and continental influences. Average annual precipitation ranges from 380 mm to 680 mm across the region. Annual snowfall averages from 160 cm to 255 cm. Winter temperatures range from lows of -15°C to highs of -5°C, and temperature inversions are common. Summer temperatures vary from lows of about 5°C to highs of about 18°C. May through September are usually frost–free.

Terrain. – The level to rolling terrain of this ecoregion is shaped by ground moraine, drumlin fields, eskers, and outwash plains, remnants of Pleistocene glaciation. Elevations range from sea level to 600 m. Slope gradients are generally less than 3°. Bedrock consists of poorly consolidated Tertiary coal–bearing rocks. Marine and lake deposits mantle portions of the region, and a considerable part of the lowlands has been blanketed by aeolian materials. Hundreds of small lakes, swamps, and bogs have developed in areas of stagnant ice topography and on ground moraines. The region was intensely glaciated during the Pleistocene epoch. There is currently little permafrost.

Soils. – Dominant soils are Haplocryands, Sphagnic Borofibrists, Terric Borosaprists, Typic Borohemists, Andic

Haplocryods, and Andic Humicryods. Surface soil layers formed in loess blown from the floodplains of glacial streams and in volcanic ash blown from mountains to the west. Subsurface soil layers formed predominantly in glacial deposits, and range from gravelly clay loam to very gravelly sandy loam. The subsurface soil layers on alluvial terraces and outwash plains are waterworked, very gravelly sand. Soils in depressions holding fens and bogs are organic and consist of peat.

Vegetation. – A variety of vegetation communities occur in the ecoregion. Needleleaf, broadleaf, and mixed forests are the most widespread (fig. 33). Tall scrub communities form thickets on periodically flooded alluvium, such as occurs on floodplains, along streambanks, and in drainageways. Mesic graminoid, graminoid herbaceous, and low scrub graminoid communities occur over a range of moist to dry sites. Poorly drained lowlands support low scrub communities. The wettest sites are colonized by tall scrub swamp, low scrub bog, wet forb herbaceous, and wet graminoid herbaceous vegetation (fig. 34).

Needleleaf forests are dominated by white spruce (*Picea glauca*), black spruce (*P. mariana*), and Sitka spruce (*Picea sitchensis*). Broadleaf forests are dominated by quaking aspen (*Populus tremuloides*), balsam poplar (*P. balsamifera*), black cottonwood (*P. trichocarpa*), and paper birch (*Betula papyrifera*). Mixed forests are codominated by combinations of these needleleaf and broadleaf species.

White spruce forests grow on well drained soils. Black spruce, paper birch, balsam poplar, and aspen may codominate with white spruce. A low shrub layer is typical, including birch (for example, *Betula glandulosa* and *B. nana*), ericaceous species (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, *Ledum groenlandicum*, and *Empetrum nigrum*), buffaloberry (*Shepherdia canadensis*), and prickly rose (*Rosa acicularis*). Herbaceous cover varies, depending upon openness of stands. Common species are *Equisetum spp.*, *Linnaea borealis*, and *Calamagrostis canadensis*. Feathermosses (for example, *Hylocomium splendens* and *Pleurozium schreberi*) form a nearly continuous layer.

Aspen forests grow on relatively warm, dry slopes. Stands may also contain balsam poplar (*Populus balsamifera*), spruce (*Picea glauca* and *P. mariana*), and paper birch (*Betula papyrifera*). Alder (*Alnus crispa*) and willow (*Salix bebbiana*) commonly provide a tall shrub layer. The low shrub layer includes prickly rose (*Rosa acicularis*), buffaloberry (*Shepherdia canadensis*), and high bushcranberry (*Viburnum edule*). The herb layer is patchy, and mosses and lichens provide little cover.

Paper birch forests are common on moderately well to well drained upland sites. White spruce and black spruce may be present. Alders (*Alnus crispa* and *A. sinuata*), willows (*Salix spp.*), and, in open stands, resin birch (*Betula glandulosa*) occur as a tall shrub layer. Prickly rose (*Rosa acicularis*), high bushcranberry (*Viburnum edule*), and ericaceous shrubs provide low shrub cover. In closed forest stands, *Calamagrostis canadensis* dominates the herb layer, and mosses and lichens are rare. In more open stands, the ground is covered by feathermosses (for example, *Hylocomium splendens* and *Pleurozium schreberi*).

Forests dominated by black spruce or a mixture of black spruce and paper birch colonize poorly drained areas. Alders (*Alnus crispa*) usually provide a tall shrub layer. Common lower shrubs are prickly rose (*Rosa acicularis*), willow (*Salix spp.*), Labrador–tea (*Ledum groenlandicum*), and ericaceous species. Feathermosses (for example, *Pleurozium schreberi* and *Hylocomium splendens*) form a patchy to continuous moss layer. Sphagnum mosses may occur on the wetter sites. Foliose lichens (for example, *Peltigera aphthosa* and *P. canina*) are common.

Floodplains and active alluvial fans support relatively pure or mixed stands of Sitka spruce (*Picea sitchensis*), black cottonwood (*Populus trichocarpa*), balsam poplar (*P. balsamifera*), and paper birch (*Betula papyrifera*). When present, the tall shrub component consists of alder and willow. Lower shrubs typically include prickly rose (*Rosa acicularis*), high bushcranberry (*Viburnum edule*), and devilsclub (*Oplopanax horridus*). Herbaceous species vary with forest type. *Gymnocarpium dryopteris*, *Athyrium filix–femina*, and *Tiarella trifoliata* occur in Sitka spruce stands; *Calamagrostis canadensis* and *Equisetum spp.* occur with black cottonwood; *Calamagrostis canadensis*, *Mertensia paniculata*, and *Epilobium angustifolium* occur with balsam poplar. Feathermosses are found in some of these communities.

Tall scrub thickets are dominated by alders (*Alnus crispa*, *A. tenuifolia*, *A. sinuata*), willows (*Salix alaxensis*, *S. brachycarpa*, and *S. planifolia*), or a combination of alders and willows. Mosses (for example, *Hylocomium splendens*, *Drepanocladus uncinatus*, and *Polytrichum spp.*) may be abundant.

Dry to mesic sites support mesic graminoid, graminoid herbaceous, and low scrub graminoid communities. Examples are communities dominated by dry fescue (*Festuca altaica*), communities codominated by midgrasses (*Festuca altaica*, *F. rubra*, *Deschampsia beringensis*, and *Poa eminens*) and forbs (for example, *Aconitum delphinifolium* and *Mertensia paniculata*), and communities codominated by midgrasses (*Festuca altaica*, *Calamagrostis purpurascens*, *Agropyron spicatum*, *Poa spp.*, *Bromus pumpellianus*) and low shrubs (for example, *Vaccinium vitis–idaea*, *Empetrum nigrum*, *Salix reticulata*, and *S. lanata*), respectively. Nonsphagnaceous mosses are common in all of these community types. Lichens may be common or absent.

Mesic to moist sites support mesic graminoid communities dominated by bluejoint (*Calamagrostis canadensis*), graminoid herbaceous communities codominated by bluejoint and herbs (for example, *Epilobium angustifolium*, *Angelica lucida*, *Athyrium filix–femina*, *Equisetum arvense*, and *E. fluviatile*), or low scrub graminoid communities dominated by bluejoint and low shrubs (for example, *Alnus sinu-*

Figure 34. Wet graminoid herbaceous communities, such as this sedge meadow, commonly occur in shallow basins in the Cook Inlet Ecoregion.

ata). Feathermosses form a patchy layer on the ground.

Low scrub communities are dominated by willows (for example, *Salix glauca* and *S. lanata*) or a mixture of willows and birch (for example, *Betula glandulosa*). The herbaceous layer typically includes graminoid species (for example, *Calamagrostis canadensis*, *Carex spp.*, and *Festuca altaica*). Mosses (for example, feathermosses) form a patchy to continuous mat.

Tall scrub swamps are dominated by alder (for example, *Alnus tenuifolia*) or combinations of alder (*A. tenuifolia*) and willow (*Salix planifolia* and *S. lanata*). Cover by low shrubs varies, but typical constituents are high bushcranberry (*Viburnum edule*), currant (*Ribes spp.*), prickly rose (*Rosa acicularis*), and Pacific red elder (*Sambucus callicarpa*). Sedges (*Carex spp.*), bluejoint (*Calamagrostis canadensis*), dwarf dogwood (*Cornus canadensis*), and horsetail (*Equisetum* spp) are typical herbaceous species. Mosses (for example, feathermosses and *Sphagnum spp.*) are common but discontinuous.

Low scrub bog communities include those dominated by low mixed shrubs (for example, *Betula glandulosa*, *B. nana*, *Ledum decumbens*, *Vaccinium vitis–idaea*, and *V. uliginosum*) and tussock–forming sedges (for example, *Eriophorum vaginatum*), ericaceous species (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, *Ledum decumbens*, *Empetrum nigrum*, and *Andromeda polifolia*), a mixture of birch (for example, *Betula glandulosa* and *B. nana*) and ericaceous species, and a mixture of willow (for example, *Salix barclayi* and *S. commutata*) and graminoid species (for example, *Calamagrostis canadensis* and *Carex spp.*). Other low shrubs (for example, *Chamaedaphne calyculata* and *Andromeda polifolia*) may be present in any of these bog communities. A nearly continuous mat of mosses (for example, *Sphagnum spp.* and feathermosses) occurs in low scrub–sedge tussock communities.

Wet forb herbaceous communities are dominated by nongraminoid species, including horsetail (for example, *Equisetum fluviatile*), buckbean (*Menyanthes trifoliata*), marsh fivefinger (*Potentilla palustris*), and marsh–marigold (*Caltha palustris*). Mosses and floating or submerged aquatic plants may be abundant.

Freshwater wet graminoid herbaceous communities are dominated by sedges (*Carex spp.*) or a mixture of sedges and low shrubs (for example, *Myrica gale* and *Salix spp.*). Mosses are common. Coastal areas may be dominated by salt–tolerant grasses (for example, *Puccinellia spp.*), sedges (for example, *Carex lyngbyaei*), and forbs (for example, *Honckenya peploides*, *Triglochin maritimum*, and *Plantago maritima*).

Wildfire. – Occurrence of wildfires in the Cook Inlet Ecoregion is low. The size of burns varies from less than 1 ha to 2,270 ha, averaging 160 ha.

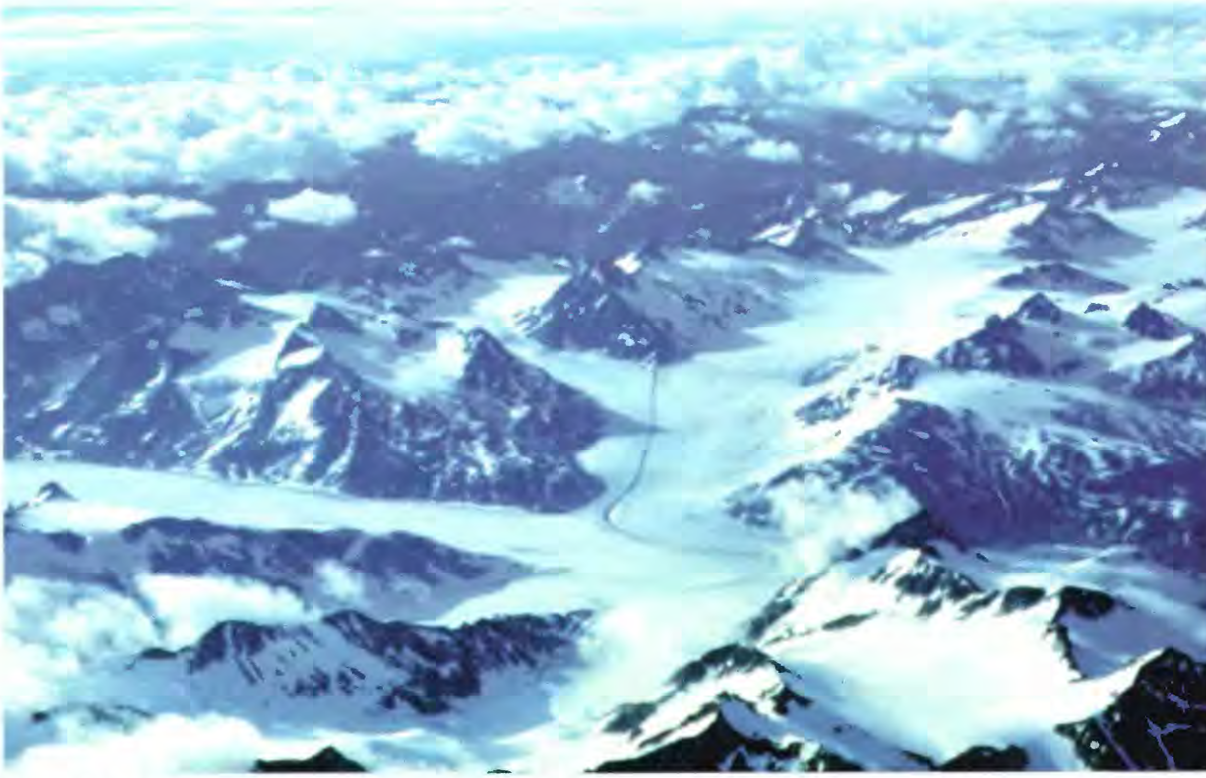

Figure 35. Extensive systems of valley glaciers in the Alaska Range Ecoregion. Features of glacial erosion, such as cirques and U-shaped valleys, are common.

Land Use and Settlement. – The Cook Inlet Ecoregion is the most populated region in Alaska. Summer and winter recreational activities occur extensively throughout the region. Agricultural activities are limited largely to the Susitna Valley, but they also occur on the Kenai Peninsula. Numerous gas and oil wells dot the Trading Bay area, and some are scattered about the Kenai Peninsula. Many oil platforms occupy the Cook Inlet. Timber production occurs on the west shore of Cook Inlet and in some areas along the Susitna River.

The Tanaina, a group of Pacific Athabascans, were the native inhabitants of the ecoregion. Their traditional diet included salmon, moose, and caribou, although these were supplemented by beaver, hare, ground squirrel, grouse, ptarmigan, migratory waterfowl, whitefish, blackfish, and pike. Edible greens, berries, and roots were also collected.

Extractable resources have included metals (for example, gold, silver, platinum, tin, copper, and tungsten) and energy–related commodities (for example, coal and uranium). Numerous sand and gravel operations support construction and road building activities.

Delineation Methods. – The ecoregion boundary represents areas less than 600 m in elevation. The boundary corresponds well with patterns on the relative CIR image. Transitional areas include the "Upland Spruce–Hardwood Forest" areas, depicted on the map "Major Ecosystems of Alaska," that occur along the interface with the surrounding mountainous ecoregions.

References. – The information provided in this regional description has been compiled from Beikman (1980), Black (1951), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992),Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

116. ALASKA RANGE

Distinctive Features. – The mountains of south central Alaska, the Alaska Range, are very high and steep. The 117,000–km^2 ecoregion is covered by rocky slopes, icefields, and glaciers (fig. 35). Much of the area is barren of vegetation. Dwarf scrub communities are common at higher elevations and on windswept sites where vegetation does exist. The Alaska Range has a continental climatic regime, but because of the extreme height of many of the ridges and peaks, annual precipitation at higher elevations is similar to that measured for some ecoregions having maritime climate.

Climate. – Climate is influenced by continental factors.

Weather data for the region are from lower elevation stations. Daily winter low temperatures average about -25°C and daily highs about -3°C at these stations. Daily summer low temperatures for the same areas average about 2°C and daily highs about 18°C. Mean annual precipitation in the lowlands is approximately 380 mm, with snowfall ranging from 150 cm to 305 cm at various stations. Estimated average annual precipitation for the higher mountains peaks is 2,030 mm, with estimated snowfall at 1,015 cm.

Terrain. – The ecoregion consists of steep, rugged mountain ridges separated by broad valleys. Elevations are 600 m in the lower valleys (sea level in the southwestern portion of the ecoregion), often rising to greater than 3,900 m on mountains peaks (Mt. McKinley is higher than 6,100 m). Slope gradients, which are almost always greater than 5° on hillslopes, exceed 25° on some mountains. The southern portion of the ecoregion is underlain by granitic batholiths intrusive into moderately metamorphosed, highly deformed Paleozoic and Mesozoic volcanic and sedimentary rocks. Large active volcanoes occur in this area. The central and eastern portions of the ecoregion are part of a broad syncline having Cretaceous rocks in the center and Paleozoic and Precambrian rocks on the flanks.

The ecoregion was heavily glaciated during the Pleistocene epoch, and extensive systems of valley glaciers still radiate from the higher mountains. Rock glaciers are common. Gelifluction features are well developed. Permafrost is discontinuous in this ecoregion; however, its full extent is unknown. Streams are swift and braided, and most are headwatered in glaciers. Many large lakes occupy the glaciated valleys within the southern part of the ecoregion. Lakes in the central and eastern part of the ecoregion are relatively rare for a glaciated area; most occur either as rock–basin lakes or as collections of small ponds in areas of ground moraine.

Soils. – Much of the ecoregion consists of rocky slopes, icefields, and glaciers. Where soil development has occurred, principal soils are Lithic Cryorthents, Pergelic Cryaquepts, Pergelic Ruptic–Histic Cryaquepts, Typic Cryochrepts, Pergelic Cryumbrepts, and Typic Cryumbrepts. Most soils are stony and shallow over bedrock, or bouldery colluvial or glacial deposits. Soils on lower slopes and in valleys are typically poorly drained, with a shallow permafrost table. Soils on upper hillsides and ridgetops are often well drained, very gravelly, and shallow over bedrock. These soils usually do not retain sufficient moisture for ice–rich permafrost.

Vegetation. – Much of the ecoregion is barren of vegetation. Dwarf scrub communities are most common where vegetation does occur, growing on well drained, windswept sites. More protected slopes provide moist to mesic sites that support low or tall scrub communities (fig. 36). Open needleleaf forests and woodlands occur on well drained sites in some valleys and on lower hillslopes (fig. 37).

Dwarf scrub communities are typically dominated by mountain–avens (*Dryas octopetala*, *D. integrifolia*, and *D. drummondii*), ericaceous species (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, *Cassiope tetragona*, *Arctostaphylos alpina*, and *A. rubra*), or combinations of these species. Graminoid species, such as sedges (for example, *Carex scirpoidea* and *C. bigelowii*) and alpine holygrass (*Hierochloë alpina*), may be present and may even codominate with shrubs, as may lichens (for example, *Alectoria spp.*, *Cetraria spp.*, *Cladonia spp.*, and *Thamnolia spp.*). Forbs (for example, *Oxytropis nigrescens*, *Hedysarum alpinum*, *Minuartia spp.*, *Anemone spp.*, and *Saxifraga spp.*) and mosses (for example, *Tomenthypnum nitens*, *Hylocomium splendens*, and *Polytrichum spp.*) typically form the ground layer of these communities.

Low scrub communities are dominated by birch (*Betula glandulosa* and *B. nana*) and ericaceous shrubs (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, *Ledum decumbens*, *Arctostaphylos spp.*, and *Empetrum nigrum*), or by willows (for example, *Salix glauca*, *S. planifolia*, and *S. lanata*). Other shrubs commonly found in these communities include red–fruit bearberry (*Arctostaphylos rubra*), bog blueberry (*Vaccinium uliginosum*), mountain–avens (*Dryas spp.*), netleaf willow (*Salix reticulata*), and arctic willow (*S. arctica*). Common herbs are fescue grass (*Festuca altaica*), alpine holygrass (*Hierochloë alpina*), Bigelow sedge (*Carex bigelowii*), arctic sweet coltsfoot (*Petasites frigidus*), and arctic wormwood (*Artemisia arctica*). Mosses (for example, *Hylocomium splendens* and *Pleurozium schreberi*) form patchy to continuous mats. Lichens (for example, *Cetraria spp. Stereocaulon tomentosum*, and *Cladonia spp.*) can be abundant.

Tall scrub communities occur at altitudinal treeline, along streambanks, in drainages, and on floodplains. These communities are dominated by willow (*Salix alaxensis*, *S. arbusculoides*, *S. planifolia*, and *S. lanata*), alder (*Alnus sinuata* and *A. crispa*), a mixture of willow and alder, or a mixture of willow and birch (*Betula glandulosa*). Low shrubs, such as Alaska bog willow (*Salix fuscescens*), Beauverd spirea (*Spiraea beauverdiana*), narrow–leaf Labrador–tea (*Ledum decumbens*), and bog blueberry (*Vaccinium uliginosum*), occur in the more open stands. Understory herbs include polar grass (*Arctagrostis latifolia*), fescue grass (*Festuca altaica*), Bigelow sedge (*Carex bigelowii*), and large–flowered wintergreen (*Pyrola grandiflora*). Mosses (for example, *Polytrichum spp.*, *Hylocomium splendens*, and *Drepanocladus uncinatus*) may be abundant in wetter stands. Lichens (for example, *Cladonia spp.* and *Stereocaulon tomentosum*) are locally abundant in drier stands.

Needleleaf forests and woodlands are dominated by white spruce (*Picea glauca*) or white spruce mixed with black spruce (*P. mariana*). The understory typically consists of low woody vegetation, such as white mountain–avens (*Dryas octopetala*), red–fruit bearberry (*Arctostaphylos rubra*), arctic willow (*Salix arctica*), crowberry (*Empetrum nigrum*), and mountain–cranberry (*Vaccinium vitis–idaea*).

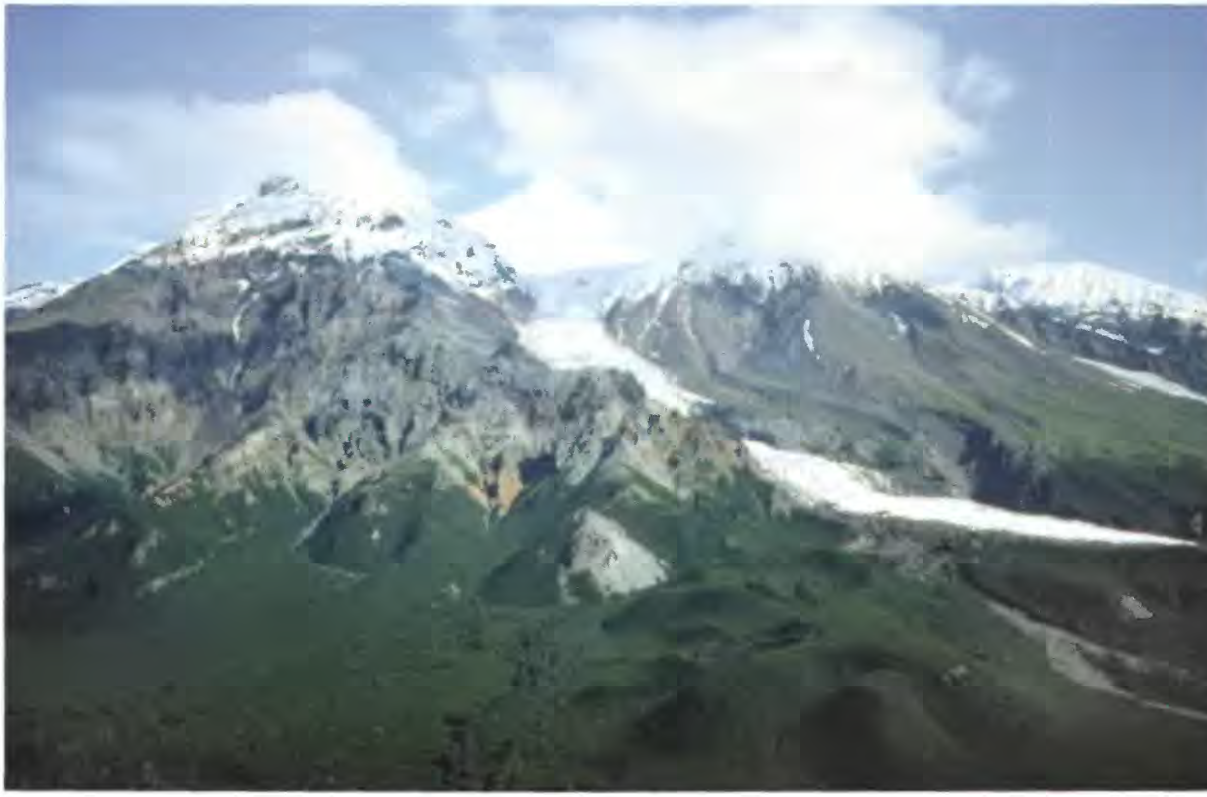

Figure 36. Mountains with middle to lower slopes blanketed with low and tall scrub communities in the Alaska Range Ecoregion. Deciduous (for example, *Populus spp.*) and coniferous (*Picea spp.*) trees often follow water tracks downslope. (Photo courtesy of Beverly Friesen, Saint Mary's College of Minnesota, Winona.)

Figure 37. White spruce woodlands on well drained lower slopes and valleys in the Alaska Range Ecoregion. The understory is resin birch.

Mosses (for example, *Pleurozium schreberi* and *Rhytidium rugosum*) grow in moist depressions. Fruticose lichens (for example, *Cetraria spp.*) are scattered throughout the understory vegetation mat.

Wildfire. – Occurrence of wildfires in the Alaska Range is low. Fires have ranged in size from less than 1 ha to 3,290 ha, with the majority of the largest fires occurring in the central and eastern portion of the ecoregion. Average area burned per fire over the entire region is about 90 ha.

Land Use and Settlement. – The few permanent settlements in this ecoregion are below 750 m elevation. The region is used primarily for recreation and subsistence hunting and fishing. Native inhabitants of the Alaska Range belong to several Athabascan groups, primarily the Tanaina, Ahtna, and Tanacross. Their livelihoods depend on salmon and freshwater fish (for example, whitefish, blackfish, and pike), large mammals (caribou, moose, and dall sheep), smaller fur–bearing mammals (for example, beaver, hare, and ground squirrel), and edible plants. Many extractable resources occur in this ecoregion; these include metals (for example, gold, silver, lead, copper, tungsten, platinum, zinc, chromium, mercury, and tin), energy-related commodities (for example, coal and uranium), and other commodities (for example, antimony, bismuth, and molybdenum).

Delineation Methods. – The ecoregion boundary follows a generalized 600–m elevation contour for separating the Alaska Range from the interior forested ecoregions. A generalized 900–m elevation contour was used to separate the Alaska Range Ecoregion from the Copper Plateau Ecoregion. The Matanuska River is the boundary between the geological formations of the Alaska Range and those of the Chugach Mountains. The mountain pass along Jack Creek and the upper Nabesna River forms the boundary between the Alaska Range and Wrangell Mountains Ecoregions. Transitional zones are areas less than 600 m in elevation along river drainages, areas where mountains higher than 600 m become more widely spaced (approximately ≥10 km apart), and areas having upland spruce–hardwood forest vegetation.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), WeatherDisc Associates, Inc. (1990), and Wibbenmeyer and others (1982).

117. COPPER PLATEAU

Distinctive Features. – The 17,000–km^2 Copper Plateau Ecoregion in south central Alaska occupies the site of a large lake that existed during glacial times. The nearly level to rolling plain has many lakes and wetlands (fig. 38). Soils are predominantly silty or clayey, formed from glaciolacustrine sediments. Much of the region has a shallow permafrost table, and soils are poorly drained. Black spruce forests and tall scrub, interspersed with wetlands, are the major types of vegetation communities.

Climate. – The ecoregion has a continental climate. Weather stations are located along the eastern side of the region. There, winter temperatures range from lows of about -27°C, to highs of about -16°C. Summer temperatures are more consistently distributed throughout the area, with average lows of about 4°C and average highs of about 21°C. Annual precipitation is lowest in the south and highest in the north, ranging from 250 mm to 460 mm. Snowfall distribution patterns are comparable, ranging from 100 cm in the south to 190 cm in the north. Although frost can occur in any month, temperatures warm enough for plant growth generally occur over a period of 11 weeks.

Terrain. – The ecoregion has smooth to rolling terrain. Elevations vary from 420 m to 900 m, with slope gradients generally less than 2°. The region is mantled in Pleistocene proglacial lake deposits that are tens to hundreds of meters thick. Most rivers head in glaciers from the surrounding mountains. Wind–blown deposits from local floodplains have developed into dunes along most of the glacial streams. The overall drainage pattern is poorly defined, but the lower stretches of the larger rivers are deeply incised in narrow valleys. The continuous permafrost layer ranges from thin to moderately thick. The permafrost table is close to the ground surface, resulting in abundant thaw lakes. The permafrost table is deep or absent in some of the very gravelly and sandy material. Lakes have formed in abandoned meltwater channels and morainal depressions.

Soils. – Principal soils are Histic Pergelic Cryaquepts, Aquic Cryochrepts, Typic Cryochrepts, Pergelic Cryaquolls, and Typic Cryoborolls. The major soils formed in silty aeolian mantles overlying calcareous silty and clayey glaciolacustrine sediments and, in places, gravelly glacial drift. Organic soils occupy some depressions. Most of the soils have a shallow permafrost table and are poorly drained. Well drained soils occur in upland areas disturbed by wildfire or in very gravelly deposits where permafrost is deep or absent. Soils with permafrost are very susceptible to alteration upon disturbance of the organic mat, because of the relatively warm (>-1.5°C) permafrost temperature. Organic mat disturbance, as by wildfire, can result in warmer soil temperatures, lowered permafrost tables, and significant

Figure 38. Widespread black spruce forest and small lakes typically encircled by bog communities are common in the Copper Plateau Ecoregion. The area is mantled with fine-textured glaciolacustrine sediments. Depth to permafrost is shallow and soils are poorly drained.

changes in soil physical properties and hydrology.

Vegetation. – Vegetation communities in the ecoregion reflect characteristics of the poor soil drainage and shallow permafrost table. Needleleaf forests and woodlands dominated by black spruce are the most common communities. Better drained sites, such as those occurring along streams, on the larger floodplains, and on south–facing slopes of very gravelly moraines, support needleleaf forests dominated by white spruce, broadleaf forests dominated by black cottonwood or aspen, and tall scrub communities. Wetlands are common and support low scrub bogs and wet graminoid herbaceous communities.

Black spruce (*Picea mariana*) forests and woodlands may include a tall shrub layer dominated by willow (for example, *Salix planifolia* and *S. glauca*) and resin birch (*Betula glandulosa*), a low shrub layer of ericaceous species (for example, *Ledum groenlandicum*, *Vaccinium vitis–idaea*, and *V. uliginosum*), and herbs (for example, *Eriophorum spp.*, *Carex spp.*, and *Equisetum spp.*). Moss cover (for example, feathermosses and *Sphagnum spp.*) is patchy to continuous. Lichens (for example, *Cladonia spp.*, *Cladina spp.*, and *Cetraria spp.*) are often present.

White spruce (*Picea glauca*) and balsam poplar (*Populus balsamifera*) stands commonly have a low shrub layer that includes prickly rose (*Rosa acicularis*) and buffaloberry (*Shepherdia canadensis*). Species of *Calamagrostis* and *Equisetum* are typical of the herb layer.

Quaking aspen (*Populus tremuloides*) stands have a low shrub understory that typically includes prickly rose (*Rosa acicularis*), a number of ericaceous species (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, and *Arctostaphylos uva–ursi*), and buffaloberry (*Shepherdia canadensis*). The ground cover usually consists of herbs (for example, *Cornus canadensis* and species of *Calamagrostis* and *Pyrola*) and mosses (for example, *Drepanocladus spp.*, *Hylocomium splendens*, and *Polytrichum spp.*).

Low scrub bogs are dominated by birch (*Betula glandulosa* and *B. nana*) and ericaceous shrubs (for example, *Vaccinium vitis–idaea*, *V. uliginosum*, *Ledum decumbens*, *Empetrum nigrum*, and *Andromeda polifolia*). Sedges (*Carex spp.*) and other herbs are common in the understory. Sphagnum mosses are abundant at most sites.

Wet graminoid herbaceous communities are typically dominated by sedges (for example, *Eriophorum angustifolium* and *Carex spp.*) or codominated by sedges and herbs (for example, *Menyanthes trifoliata*, *Petasites frigidus*, and *Potentilla palustris*). Mosses (for example, *Sphagnum spp.*) are common.

Wildfire. – Occurrence of wildfires in the Copper Plateau Ecoregion is low. Size of burn typically is small, ranging from less than 1 ha to about 40 ha, with a mean of 5 ha.

Figure 39. The Wrangell Mountains Ecoregion is extensively covered by ice fields and glaciers. Most slopes are barren of vegetation; however, dwarf scrub communities predominate where vegetation does occur. (Photo courtesy of M. Woodbridge Williams, National Park Service, Anchorage.)

Land Use and Settlement. – A few small settlements occur in the region. The region has traditionally been used for subsistence hunting and fishing by the Ahtna Athabascans. Their principal resources for food and materials are salmon and freshwater fish, large game (for example, caribou and moose), small fur–bearing mammals (for example, beaver, hare, and ground squirrel), and edible plants. Some mining activities have occurred, such as those related to extraction of gold and selenium.

Delineation Methods. – A generalized 900–m elevation contour was used to delineate the boundary of the Copper Plateau Ecoregion. This boundary corresponds with patterns on the relative CIR image. Because the ecoregion is typified by features that relate to low and very low terrain roughness, steeper, more variable terrain has been depicted as transitional.

References. – The information provided in this regional description has been compiled from Beikman (1980), Black (1951), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

118. WRANGELL MOUNTAINS

Distinctive Features. – The 29,000–km² Wrangell Mountains Ecoregion consists of steep, rugged mountains of volcanic origin that are extensively covered by ice fields and glaciers (fig. 39). Most slopes are barren of vegetation. Dwarf scrub tundra communities, consisting of mats of low shrubs, forbs, grasses, and lichens, predominate where vegetation does occur. The climate has harsh winters and short summers.

Climate. – Climate is primarily affected by continental influences. The only weather station within the region is located at McCarthy. There, winter low temperatures average -34°C, and winter highs average -9°C. Mean summer low temperature is 3°C, and mean summer high is 22°C. The average number of frost–free days each year is somewhat less than 2 months. McCarthy receives an average of 410 mm of precipitation per year, of which 175 cm is snow. Higher elevations may receive 2,030 mm of precipitation annually, including 255 cm of snow.

Terrain. – The ecoregion represents a large group of shield and composite volcanoes of Cenezoic age; Mount

Figure 40. Typical glacial till parent material in valley soils of the Wrangell Mountains Ecoregion. Deposits, such as these left by the receding Kennicott Glacier, can deeply mantle valley floors and provide considerable sediment loading to streams.

Wrangell remains an active volcano. These volcanic formations lie over Paleozoic and Mesozoic sedimentary and volcanic rocks. The terrain is steep and rugged, with most slope gradients exceeding 7° and many (15 percent of the ecoregion) surpassing 15°. Elevations start at 600 m, and most of the largest peaks are 3,900 m or more, with a couple of peaks exceeding 4,880 m. The mountains were glaciated during the Pleistocene epoch, and extensive glaciation persists. Permafrost is discontinuous. Streams headwater in glaciers, and their drainages radiate outward from the region. There are few lakes.

Soils. – Much of the landscape consists of steep rocky slopes, icefields, and glaciers. Soil development has resulted in thin, stony soils that are shallow over bedrock or bouldery deposits. Most soils have formed in very stony and gravelly colluvial material. Soils in valleys and on footslopes have formed in glacial till (fig. 40), with a thin mantle of volcanic ash or loess in some places. Most soils are poorly drained, but well drained soils do occur in very gravelly material at the foot of high ridges, on some south–facing slopes, and on hilly moraines at lower elevations. Principal soils are Lithic Cryorthents, Typic Cryorthents, Pergelic Cryochrepts, and Pergelic Cryumbrepts.

Vegetation. – Most slopes in the mountains are barren of vegetation. Dwarf scrub communities dominate where vegetation does occur, growing on well drained, windy sites. Tall scrub communities occur along drainages and on floodplains. Broad ridges, valleys, and hilly moraines at lower elevations support needleleaf forests dominated by white spruce or broadleaf forests dominated by paper birch or aspen.

Dwarf scrub communities are dominated by mountain–avens (*Dryas drummondii*, *D. integrifolia*, and *D. octopetala*), ericaceous shrubs (for example, *Vaccinium vitis–idaea* and *V. uliginosum*), or willow (for example, *Salix rotundifolia*, *S. polaris*, *S. reticulata*, and *S. arctica*). Typical herbaceous vegetation includes *Carex spp.*, *Festuca spp.*, *Anemone spp.*, and *Saxifraga spp.* Lichens (for example, *Cladina spp.*, *Cetraria spp.*, and *Cladonia spp.*) may provide substantial cover and may codominate with shrubs.

Tall scrub communities are dominated by willow (for example, *Salix lanata*, *S. alaxensis*, *S. barclayi*, and *S. planifolia*) and alder (for example, *Alnus sinuata*). The understory consists of herbs, typically including both graminoid and broad–leaved species, and mosses (primarily feathermosses).

Forests dominated by white spruce (*Picea glauca*) typically include understory shrubs, such as willow (*Salix spp.*), alder (*Alnus spp.*), and birch (*Betula spp.*). A nearly continuous layer of feathermosses covers the ground.

Forests dominated by paper birch (*Betula papyrifera*) or quaking aspen (*Populus tremuloides*) are typically accompanied by an understory shrub layer, including alder (*Alnus spp.*), willow (*Salix spp.*), prickly rose (*Rosa acicularis*), and high bushcranberry (*Viburnum edule*). Herbaceous cover is variable, often including species such as bluejoint (*Calamagrostis spp.*), horsetail (*Equisetum spp.*), and twinflower (*Linnaea borealis*). A layer of mosses (primarily feathermosses) or, on drier sites, lichens is common under open stands of paper birch.

Wildfire. – Occurrence of lightning fires in the Wrangell Mountains is very low. Gabriel and Tande (1983) report no fires during the 22–year period of record examined.

Land Use and Settlement. – Perennial settlements are rare, mostly located in the lower valleys. The region has traditionally provided subsistence resources for Athabascans of the Upper Tanana and Ahtna groups. Salmon and freshwater fish, caribou, moose, dall sheep, beaver, hare, and ground squirrels are typical sources of food and materials. Edible and medicinal plants are also collected.

A belt of copper deposits lies on the south side of the region and has been economically important. Other important metals have included silver, gold, lead, and zinc.

Delineation Methods. – The Chitina River, up through Logan Glacier, was used to separate the geologic formations of the Wrangell Mountains Ecoregion from those of the Pacific Coastal Mountains Ecoregion. The mountain pass along Jack Creek and the upper Nabesna River forms the boundary between the Wrangell Mountains and the Alaska Range Ecoregions. A generalized 900–m elevation contour was used to separate the Wrangell Mountains from the Copper Plateau. Moderate to very high terrain roughness was used to distinguish the mountains from the bottomlands of the Tetlin National Wildlife Refuge, to the north. The boundary between the Wrangell Mountains and the Interior Highlands Ecoregions was based on a generalized 600–m elevation contour. Transitional areas are those having vegetation other than alpine tundra ecosystems.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990)

119. PACIFIC COASTAL MOUNTAINS

Distinctive Features. – The steep and rugged mountains along the southeastern and south central coast of Alaska receive more precipitation annually than either the Alaska Range or Wrangell Mountains Ecoregions. Glaciated during the Pleistocene epoch, most of the 106,000–km² ecoregion is still covered by glaciers and ice fields. Most of the area is barren of vegetation (fig. 41), but where plants do occur, dwarf and low scrub communities dominate.

Climate. – Climate for most of the ecoregion is transitional between maritime and continental influences. There are no long–term weather stations in this ecoregion. Climatic patterns within the region are affected by elevation, latitude, and geographic position. Interpolation of data from the low–elevation stations of the adjacent coastal ecoregion estimates an annual precipitation ranging from 2,030 mm to greater than

Figure 41. Glaciers and ice fields, remaining since the Pleistocene epoch, are typical of the Pacific Coastal Mountains Ecoregion. The ecoregion is predominantly barren of vegetation, but alpine tundra communities occur where conditions permit. (Photo courtesy of Ray Koleser, Forest Service, Forestry Sciences Laboratory, Anchorage.)

7,000 mm, increasing with elevation and in a south–to–north direction. Estimated annual snowfall ranges from 510 cm to 2,030 cm and follows the same distribution pattern.

Terrain. – Steep, rugged mountains covered by many active glaciers are typical of this ecoregion. Elevations range from sea level to more than 4,500 m. Higher parts of the ecoregion are buried in ice fields, from which valley and piedmont glaciers radiate. Slope gradients for most of the region are greater than 7°; slope gradients for 5 percent of the region exceed 20°. Geologic formations of Cretaceous and Upper Jurassic sediments occur extensively throughout the Chugach Mountains. Tertiary to Cretaceous (Paleozoic in some places) intrusive rock occurs throughout the southeastern portion of the ecoregion. The Chugach Mountains are underlain by isolated masses of permafrost. The mountains of the southern half of the region are generally free of permafrost. The ecoregion was extensively glaciated during the Pleistocene epoch, and many glaciers remain. Features typical of glaciated terrain, such as arêtes, horns, cirques, U–shaped valleys, and morainal deposits in valleys and on lower hillslopes, are abundant. Streams are short and swift, and headwatered in glaciers. Lakes lie in ice–carved basins.

Soils. – Most areas are covered by glaciers, ice fields, or rock outcrops. Where soil development has occurred, soils have formed in gravelly till and colluvium. Soils on steep ridges are shallow over bedrock. Dominant soils are Lithic Cryorthents, Andic Cryumbrepts, Pergelic Cryumbrepts, Typic Cryumbrepts, Typic Haplocryods, Andic Humicryods, Lithic Humicryods, and Typic Humicryods.

Vegetation. – The principal nature of this ecoregion is alpine slopes barren of vegetation or dwarf and low scrub communities in areas where vegetation does occur. There are many areas where needleleaf forests, originating in adjacent, lower elevation ecoregions, colonize mesic sites along drainageways.

Dwarf scrub communities are typically dominated by mountain heath (*Phyllodoce aleutica*). Associated shrubs include cassiope (*Cassiope mertensiana* and *C. stelleriana*), meadow–spirea (*Luetkea pectinata*), bog blueberry (*Vaccinium uliginosum*), and dwarf blueberry (*V. caespitosum*).

Low scrub communities dominated by ericaceous shrubs (for example, *Cladothamnus pyrolaeflorus*) form dense thickets at lower elevations in the ecoregion where snow cover persists until late spring.

Needleleaf forest stands are dominated by hemlock (*Tsuga heterophylla* or *T. mertensiana*) and subalpine fir (*Abies lasiocarpa*) or by Sitka spruce (*Picea sitchensis*). The understory layer consists of ericaceous shrubs (for example, *Vaccinium alaskaense*, *V. ovalifolium*, and *Menziesia ferruginea*), raspberry (*Rubus spp.*), currant (*Ribes spp.*), and devilsclub (*Oplopanax horridus*). The forest floor is typically covered by herbs (for example, *Tiarella trifoliata* and *Streptopus spp.*) and a number of fern species.

Wildfire. – Wildfire information is only available for the northern portion of the ecoregion, in the Chugach Mountains, where occurrence is very low. Burn areas have ranged in size from less than 1 ha to 40 ha, averaging 4 ha.

Land Use and Settlement. – Permanent settlements are rare in this ecoregion, primarily occurring at the lower elevations. The eastern half of the region has historically been used by the Tlingits, and the western half has been used by the Chugach and Eyak peoples. Moose, mountain goat, and smaller mammals are hunted in the mountains. Streams yield salmon and freshwater fish. Coastal areas provide marine resources as well as coastal birds and their eggs. Edible greens, roots, and berries are also collected.

In addition to subsistence and recreational hunting and fishing, the region has supplied a variety of metallic elements (for example, gold, silver, copper, zinc, lead, tungsten, iron, nickel, platinum, barium, and chromium), nonmetallic elements (for example, antimony, arsenic, and molybdenum), and energy–related commodities (coal, petroleum, and uranium).

Delineation Methods. – The boundary of the southern section of the ecoregion excludes the western hemlock–Sitka spruce forests of the Pacific Coast. The northern boundary is based on Logan Glacier, along the interface with the Wrangell Mountains; a generalized 900–m elevation contour, along the interface with the Copper Plateau; the Matanuska River, along the interface with the Alaska Range; and a generalized 600–m elevation contour, along the interface with the Cook Inlet Ecoregion. Transitional areas are those having forests.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Gabriel and Tande (1983), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Forest Service (1992), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

120. COASTAL WESTERN HEMLOCK–SITKA SPRUCE FORESTS

Distinctive Features. – Located along the southeastern and south central shores of Alaska, the terrain of this 61,000–km² ecoregion is a result of intense glaciation during late advances of the Pleistocene epoch. The deep, narrow

Figure 42. The Coastal Western Hemlock-Sitka Spruce Forests Ecoregion has deep, narrow bays and steep, dissected valley walls covered by highly productive forests. The ecoregion receives large amounts of precipitation and has the mildest winter temperatures of all ecoregions in Alaska. (Photo courtesy of Ken Winterberger, Forest Service, Forestry Sciences Laboratory,

bays, steep valley walls that expose much bedrock, thin moraine deposits on hills and in valleys, very irregular coastline, high sea cliffs, and deeply dissected glacial moraine deposits covering the lower slopes of valley walls are all evidence of the effects of glaciation. The region has the mildest winter temperatures in Alaska, accompanied by large amounts of precipitation. Forests of western hemlock and Sitka spruce are widespread (fig. 42).

Climate. – The ecoregion has a maritime climate, with cool summers and mildly cold winters. Moderate to heavy precipitation occurs throughout the year, though storms are most frequent and heavy during the winter. Surface winds are moderate to strong, with prevailing winds coming from the south or southeast. The average frost–free season is about 7 months. Mean annual precipitation ranges from 1,350 mm to 3,900 mm, depending on location. Mean annual snowfall ranges from 80 cm to 600 cm. Daily minimum temperature in winter is about -3°C at many weather stations, and daily maximum temperature averages about 3°C. Mean daily minimum temperature in summer is about 7°C, and maximum temperature is about 18°C.

Terrain. – The ecoregion includes the steep footslopes, alluvial fans, floodplains, outwash plains, scattered moraines, river terraces, and river deltas of the Pacific coastal mountains. Elevations climb from sea level to 500 m (including some local mountains up to 1,000 m). Slope gradients range from 0° to 28°, with a median of 5°. Geologic formations are Lower Tertiary interbedded sedimentary, volcanogenic, and volcanic rocks in the Prince William Sound area, Upper Cretaceous sandstone and slate on Kodiak Island, and Mesozoic volcanic and intrusive rock along with Mesozoic and Paleozoic sediments in the southeastern portion of the ecoregion. More recent formations are dunes of aeolian sand that border some of the floodplains throughout the ecoregion. Nearly all of the ecoregion was subject to late glacial advances during the Pleistocene epoch, although no glaciers remain. The region is generally free from permafrost. Most streams originate from the mountain glaciers of adjoining ecoregions; exceptions are streams on islands. Lakes are plentiful in some areas and absent in others.

Soils. – Dominant soils are Terric Cryohemists, Andic Cryaquods, Andic Humicryods, Lithic Humicryods, and Typic Humicryods. Soils near the mountains formed in gravelly and stony moraine deposits or in a mantle of volcanic ash over the morainal deposits. Soils of river deltas, terraces, alluvial fans, and floodplains formed in waterlain silts and clays. Poorly drained depressions are filled with fibrous peat. Many parts of the ecoregion are susceptible to flooding or to inundation by tidewater. Ash–influenced soils are located on Kruzof Island and areas of Baranof Island.

Vegetation. – The relatively long growing season, high annual precipitation, and mild temperatures of this ecoregion support a large variety of coastal forest, scrub, and wetland communities. Forests, which may be dominated by needleleaf or broadleaf species, or a mixture of both, predominate. Scrub communities are dominated by tall shrubs, low shrubs, or dwarf shrubs. Wetland sites support tall scrub swamps, low scrub bogs, wet graminoid herbaceous communities, and wet forb herbaceous communities.

A large variety exists in the dominant and codominant constituents of forested communities. Western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*) are the two most typifying species of the region, but a variety of other trees also occur, including silver fir (*Abies amabilis*), subalpine fir (*A. lasiocarpa*), lodgepole pine (*Pinus contorta*), Pacific yew (*Taxus brevifolia*), alder (*Alnus rubra*), and black cottonwood (*Populus trichocarpa*). Understory vegetation varies somewhat with forest type. Typical woody species include alder (*Alnus spp.*), willow (*Salix spp.*), currant (*Ribes spp.*), salmonberry (*Rubus spectabilis*), prickly rose (*Rosa acicularis*), red–fruit bearberry (*Arctostaphylos rubra*), cranberry/blueberry (for example, *Vaccinium alaskaense, V. ovalifolium, and V. parvifolium*), high bushcranberry (*Viburnum edule*), dwarf dogwood (*Cornus canadensis*), devilsclub (*Oplopanax horridus*), and five–leaf bramble (*Rubus pedatus*). Herbaceous cover is supplied by bluebell (*Mertensia paniculata*), false lily–of–the–valley (*Maianthemum dilatatum*), laceflower (*Tiarella trifoliata*), deer cabbage (*Fauria crista–galli*), twisted stalk (*Streptopus spp.*), goldthread (*Coptis aspleniifolia*), sedge (*Carex spp.*), reed–grass (*Calamagrostis spp.*), and ferns (for example, *Gymnocarpium dryopteris, Dryopteris dilatata, Athyrium filix–femina*, and *Blechnum spicant*). Mosses (for example, *Hylocomium splendens, Pleurozium schreberi*, and *Drepanocladus uncinatus*) are common.

Scrub communities range from tall scrub to dwarf scrub. Tall scrub communities are dominated by willow (for example, *Salix alaxensis, S. planifolia, S. lanata*, and *S. sitchensis*), alder (*Alnus tenuifolia*), or a mix of willow and alder. An understory scrub layer is typically absent, but cover by herbs (for example, *Calamagrostis canadensis, Festuca altaica, Equisetum spp., Epilobium spp., Mertensia paniculata, Aconitum delphinifolium*, and *Athyrium filix–femina*) may be dense. Mosses (for example, *Polytrichum spp., Hylocomium splendens*, and *Drepanocladus uncinatus*) form a patchy to continuous mat.

Low scrub communities are dominated by copperbush (*Cladothamnus pyrolaeflorus*) or by a mix of willow (for example, *Salix glauca, S. planifolia*, and *S. lanata*) and alder (for example, *Alnus sinuata*). Although copperbush communities generally have no significant associated species, communities dominated by willow and alder are often accompanied by ericaceous shrubs (for example, *Arctostaphylos alpina, Empetrum nigrum*, and *Vaccinium vitis–idaea*) and nonsphagnaceous mosses.

Dwarf scrub communities occur at higher elevation, where sites are exposed to harsh climatic elements. Mountain–heath (*Phyllodoce aleutica*) is the dominant species. Associated dwarf shrubs include cassiope (*Cassiope mertensiana* and *C. stelleriana*), meadow–spirea (*Luetkea pectinata*), bog blueberry (*Vaccinium uliginosum*), dwarf blueberry (*V. caespitosum*), Nootka lupine (*Lupinus nootkatensis*), Sitka valerian (*Valeriana sitchensis*), and roseroot (*Sedum rosea*). Mosses and lichens can be common.

Tall scrub swamps are usually dominated by alder (*Alnus tenuifolia*) but are sometimes dominated or codominated by willow (for example, *Salix planifolia* or *S. lanata*). Typical herbs are bluejoint (*Calamagrostis canadensis*) and horsetail (*Equisetum spp.*).

Low scrub bogs are dominated by low ericaceous shrubs (for example, *Empetrum nigrum, Vaccinium oxycoccus, Andromeda polifolia*, and *Kalmia Polifolia*), a mixture of willow (*Salix spp.*) and graminoid species (for example, *Calamagrostis canadensis, Carex aquatilis*, and *C. pluriflora*), or a mixture of sweetgale (*Myrica gale*) and graminoid species (*Calamagrostis canadensis, Trichophorum spp.*, and *Carex spp.*). Mosses (usually including *Sphagnum spp.*) occur at most sites.

Wet graminoid herbaceous communities are dominated by sedges (for example, *Scirpus validus, Eleocharis palustris*, and *Carex spp.*), a mixture of sedges and mosses (principally *Sphagnum spp.*), or a mixture of sedges and shrubs (*Myrica gale* or *Salix spp.*). Woody plants are lacking from the first two community types, and lichens are lacking from all three.

Wet forb herbaceous communities are typically dominated by one or more of the following: swamp horsetail (*Equisetum spp.*), yellow marsh–marigold (*Caltha palustris*), buckbean (*Menyanthes trifoliata*), and marsh fivefinger (*Potentilla palustris*). Woody plants and lichens are lacking from these communities, though aquatic mosses are common.

Wildfire. – Lightning fires are rare in this ecoregion; however, no data have been recorded regarding the frequency and size of burns.

Land Use and Settlement. – Population is concentrated along small stretches of flat coastal areas. Timber harvest and mining are the primary economic activities. A variety of metallic elements occur in this ecoregion, including gold, copper, silver, zinc, lead, iron, platinum, titanium, barium, nickel, cobalt, and chromium. Nonmetallic elements include antimony, arsenic, calcium, molybdenum, and sulfur. Energy–related commodities, such as coal, uranium, and petroleum, have also been investigated and mined.

The ecoregion has traditionally been populated by

Tlingit and Haida groups in the eastern half and by Eyak, Chugach, Uneqkurmuit, and Koniag peoples in the western half. Mainland dwellers base their subsistence on salmon, eulachon (an important source of oil), moose, and mountain goat. Because island dwellers have access to smaller salmon runs, they make more use of marine resources, such as herring, halibut, and seaweed. Both mainland and island groups supplement their diets with deer, birds (for example, cranes, ducks, geese, grouse, and ptarmigan) and their eggs, seals (hunted at rookeries), intertidal resources (for example, clams, cockles, and chitons), and edible plants.

Delineation Methods. – The ecoregion boundary is based on the extent of "Coastal Western Hemlock–Sitka Spruce Forest," as shown on the maps "Major Ecosystems of Alaska" and forest types (Powell and others, 1993). This boundary corresponds with patterns on the relative CIR image. Because individual land units are small and environmental gradients are steep, it is not possible to delineate transitional zones at the current scale of mapping.

References. – The information provided in this regional description has been compiled from Beikman (1980), Coulter and others (1962), Ferrians (1965), Joint Federal-State Land Use Planning Commission for Alaska (1973), Karlstrom and others (1964), Langdon (1993), Larson and Bliss (written commun., 1992), Moore (written commun., 1993), Morgan (1979), Ping (written commun., 1993), Powell and others (1993), Reiger and others (1979), Selkregg (1974), U.S. Bureau of Mines (1992a, 1992b), U.S. Forest Service (1992), U.S. Geological Survey (1964, 1987a), Viereck and Little (1972), Viereck and others (1992), Wahrhaftig (1965), and WeatherDisc Associates, Inc. (1990).

SUMMARY

We have mapped and described 20 ecoregions of Alaska to serve as a framework for organizing and interpreting environmental data relevant to a wide range of regional ecological concerns. Examples of applications for the map include the assessment of natural resources (for example, regional chemical, physical, and biological characteristics of surface waters, soil erosion potential, and wildlife habitat diversity) and effects research (for example, potential regional ecological effects from environmental contaminants or climate change). The map can also be used in developing strategies for locating field sites or in evaluating how well existing research sites are distributed across ecoregions or along regional environmental gradients.

The regional descriptions accompanying the map indicate the degree of ecological variability occurring within each ecoregion. This information can be used to infer the relative density of sample sites needed to represent each ecoregion and the within–region areas over which field sample information can be extrapolated.

The ecoregion map was compiled by synthesizing information on the geographic distribution of environmental factors such as climate, physiography, geology, soils, permafrost, glaciation, hydrology, and vegetation. The synthesis was a qualitative assessment of the distributional patterns of these factors and their relative importance in influencing the nature of the landscape from place to place. The actual placement of ecoregion boundaries was achieved by following boundaries from a selected subset of mapped references that best integrated the patterns of the major factors of interest for each ecoregion.

An accuracy assessment was not performed on the map of Alaskan ecoregions. There are several problems associated with determining map accuracy, such as inability to sufficiently field sample the number of variables that define each ecoregion, inability to sample a sufficient number of (largely inaccessible) field sites to represent the range of within–region ecological variability, and difficulty in designing a sampling strategy that reconciles the differences in informational resolution between field samples and the ecoregion map. It may be more appropriate to assess the utility of the ecoregion map for different needs than to assess its accuracy. This is because the ecoregion boundaries have been delineated to be generally correct for a number of purposes but not necessarily precise for any singular purpose or variable.

The 20 ecoregions of Alaska are being aggregated into coarser ecological units for developing a North American map of ecoregions. A map of ecoregions has already been developed for Canada and has been integrated across the international border with the map of Alaskan ecoregions. Also under way are efforts to delineate ecoregions of other northern circumpolar areas to promote international programs involved with assessing and monitoring global resources.

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APPENDIXES 1-3

Appendix 1.–Table of major environmental characteristics occurring in each ecoregion

Ecoregion	Climate[a] (1)[b]	Physiography (2)	Geology (3)	Permafrost (4)	Soils (5)	Vegetation (6)	Pleistocene Glaciation (7)
101. Arctic Coastal Plain (50,000 km^2) (1, 2, 4, 6)[c]	Arctic. Ann. precip.[d] ≈140 mm. Ann. snowfall 30 cm to 75 cm. Avg. daily min. temp. in winter is –30°C; avg. daily max. in summer is ≈8°C.	Nearly level plain. Elevations from sea level to 180 m[e]. Slope gradients ≤1°.	Quaternary deposits of alluvial, glacial, and aeolian origin.	Underlain by continuous thick permafrost.	Histic Pergelic Cryaquepts and Pergelic Cryaquepts.	Wet graminoid herbaceous communities predominate. Dwarf scrub communities in areas where microtopography provides deeper rooting zone.	None.
102. Arctic Foothills (124,000 km^2) (1, 2, 4, 6)	Arctic. Ann. precip. ≈140 mm, up to 190 mm near Brooks Range. Ann. snowfall 75 cm to 130 cm. Avg. daily min. temp. in winter is –29°C; avg. daily max. in summer is 11°C to 15°C.	Broad, rounded ridges and mesas in northern section; irregular buttes, mesas, long, linear ridges, and undulating plains and plateaus in southern section. Elevations from sea level to 800 m. Slope gradients generally 0° to 5°.	Northern section has unconsolidated Quaternary deposits of glacial, alluvial, and aeolian origin. Southern section has undifferentiated alluvial and colluvial deposits over Jurassic and early Cretaceous formations.	Underlain by continuous thick permafrost.	Histic Pergelic Cryaquepts, Pergelic Cryaquepts, and Pergelic Ruptic–Histic Cryaquepts.	Mesic graminoid herbaceous communities predominate. Dwarf scrub on other well-drained sites. Open low scrub along drainages.	None, except for some areas directly north of the Brooks Range.
103. Brooks Range (134,000 km^2) (1, 2, 3, 4, 6, 7)	Arctic. Ann. precip. at Anaktuvuk Pass (the only long–term weather station in the region) 280 mm. Ann. snowfall 160 cm. Avg. daily min. temp. in winter at Anaktuvuk Pass is –30°C; avg. daily max. in summer for same location is 16°C.	Steep, rugged mountains. Elevations from 500 m to >2,400 m. Slope gradients generally 5° to 15°.	Stratified Paleozoic and Mesozoic sedimentary deposits. Much exposed bedrock and rubble.	Underlain by continuous thick permafrost.	Pergelic Cryaquepts, Pergelic Cryumbrepts, and Lithic Cryorthents.	Much of region is barren of vegetation. Dwarf scrub communities on drier sites. Mesic graminoid herbaceous communities on wet to moist sites in lower valleys.	Extensive.
104. Interior Forested Lowlands and Uplands (269,000 km^2) (2, 3, 6, 7)	Continental. Ann. precip. 250–550 mm, usually increasing with elevation. Ann. snowfall 125 cm to 205 cm. Avg. daily min. temp. in winter is –35°C to –18°C; avg. daily max. in summer is 17°C to 22°C.	Rolling lowlands, dissected plateaus, and low to high hills. Elevations from sea level to 500 m. Slope gradients generally 0° to 5°.	Predominantly Mesozoic and Paleozoic sedimentary rocks, but also extensive areas of volcanic deposits. Region is covered by undifferentiated alluvium and slope deposits. Little bedrock exposure.	Western portion underlain by thin to moderately thick permafrost. Eastern portion underlain by discontinuous permafrost.	Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, Pergelic Cryochrepts, Typic Cryochrepts, Typic Cryorthents, and Pergelic Cryumbrepts.	Needleleaf, broadleaf, and mixed forests predominate. Tall scrub communities on newly exposed alluvium, burned or disturbed areas, and at treeline. Low scrub in moist areas and on north–facing slopes. Tall scrub swamps, low scrub bogs, and scrub-graminoid communities in wettest areas.	None.

[a]Climate information for nearly all ecoregions represents interpolations from very few weather stations.
[b]Numbers below headings of environmental characteristics correspond with those listed in footnote c.
[c]Numbers indicate the mapped environmental characteristics most useful for distinguishing the ecoregion and do not necessarily reflect the primary ecological driving factors: 1=climate, 2=physiography, 3=geology, 4=permafrost, 5=soils, 6=vegetation, and 7=Pleistocene glaciation.
[d]Includes snow water equivalent.
[e]Elevation is in meters above mean sea level.

Ecoregion	Climate (1)	Physiography (2)	Geology (3)	Permafrost (4)	Soils (5)	Vegetation (6)	Pleistocene Glaciation (7)
105. Interior Highlands ($115,000\ km^2$) (2, 6, 7)	Continental. No long–term weather data available. Likely increasing precip. and decreasing temp. with rise in elevation.	Steep, round ridges often capped by rugged peaks. Elevations from 500 m to >1,500 m. Slope gradients generally 5° to 15°, lower gradients typical around margins of ecoregion.	Paleozoic and Precambrian metamorphic rocks, felsic volcanic and intrusive rocks. Kuskokwim Mountains and Nulato Hills have Cretaceous and Lower Paleozoic sedimentary rocks. Much more bedrock exposure than Interior Forested Lowlands and Uplands Ecoregion.	Northern portions are underlain by continuous permafrost. Central and southern portions are underlain by discontinuous permafrost.	Histic Pergelic Cryaquepts, Typic Cryochrepts, Pergelic Cryumbrepts, Lithic Cryorthents, and Typic Cryorthods.	Dwarf scrub on sites exposed to harsh climatic elements. Needleleaf forests and woodlands at lower elevations. Mesic graminoid herbaceous communities in poorly drained areas.	On higher peaks.
106. Interior Bottomlands ($103,000\ km^2$) (2, 3, 6)	Continental. Ann. precip. 280 mm to 400 mm. Wetter in west, drier in east. Ann. snowfall 95 cm to 205 cm. Avg. daily min. temp. in winter is –33°C to –26°C; avg. daily max. in summer is 22°C.	Flat to nearly flat bottomlands, inclusion of local hills. Elevations from 120 m to 600 m. Slope gradients generally <1°.	Fluvial and aeolian deposits of mixed origin. Outwash gravel and morainal deposits in some areas.	Ranges from isolated masses of permafrost to continuous thin permafrost.	Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, Typic Cryochrepts, and Typic Cryofluvents.	Needleleaf, broadleaf, and mixed forest communities are widespread. Tall scrub communities on floodplains. Low scrub bogs, wet graminoid herbaceous meadows, and wet forb herbaceous meadows and marshes in wettest sites.	None.
107. Yukon Flats ($33,000\ km^2$) (2, 3, 4, 6)	Continental. Ann. precip. 170 mm. Ann. snowfall 115 cm. Avg. daily min. temp. in winter is ≈–34°C; avg. daily max. in summer is ≈22°C.	Flat to undulating basin floor. Elevations from 90 m to >250 m. Slope gradients generally <1°.	Quaternary alluvial (and some aeolian) deposits.	Permafrost widespread but discontinuous.	Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, and Pergelic Cryochrepts.	Needleleaf, broadleaf, and mixed forest communities widespread. Tall scrub communities on alluvial sites subject to periodic flooding. Tall scrub swamps and wet graminoid herbaceous communities in wettest areas.	None.
108. Ogilvie Mountains ($11,000\ km^2$) (Region is most distinguishable on vegetation greenness images. Other important characteristics are distinctive mainly in Canada.)	Continental. No long–term weather data available. Ann. precip. probably from 500 mm to 650 mm. Ann. snowfall probably from 130 cm to 205 cm. Estimated avg. daily min. temp. in winter is –32°C; estimated avg. daily max. in summer is 22°C.	Predominantly flat–topped hills, sometimes overtopped by mountains, eroded from a former plain. Elevations from 900 m to >1,300 m. Slope gradients generally 0° to 5°.	Metamorphic and sedimentary rocks, primarily dolomite, phyllite, argillite, limestone, shale, chert, sandstone, and conglomerate. Karst topography common.	Permafrost widespread but discontinuous.	Histic Pergelic Cryaquepts, Typic Cryochrepts, and Pergelic Cryorthents	Mesic graminoid herbaceous communities widespread on exposed sites. Needleleaf, broadleaf, and mixed forest communities on lower hillslopes and in valleys. Tall scrub communities mainly at lower elevations, sometimes extending above timberline.	None.

Ecoregion	Climate (1)	Physiography (2)	Geology (3)	Permafrost (4)	Soils (5)	Vegetation (6)	Pleistocene Glaciation (7)
109. Subarctic Coastal Plains (91,000 km^2) (2, 3, 4, 5, 6)	Transitional. Ann. precip. 250 mm to 500 mm. Ann. snowfall 100 cm in north, 105 cm to 150 cm in south. Avg. daily min. temp. in winter is –25°C for the Kotzebue Sound area and –20°C to –15°C for the Cape Denbigh and Yukon– Kuskokwim Lowland areas; avg. daily max. temp. in summer is 13°C to 17°C.	Flat plains. Elevations from sea level to >120 m. Slope gradients generally <1°.	Older coastal deposits of interstratified alluvial and marine sediments. Includes areas of Quaternary mafic and undifferentiated volcanic rocks in western part of Yukon–Kuskokwim Lowlands and on Nunivak and St. Lawrence Islands. Cretaceous intermediate volcanic rocks in Selawik Wildlife Refuge Area.	Continuous thin to moderately thick permafrost.	Histic Pergelic Cryaquepts and Pergelic Cryofibrists.	Wet graminoid herbaceous communities predominate. Dwarf scrub communities in better drained areas. Needleleaf forests in southern portion of region, where drainage and warm temperatures sufficient .	Only northernmost portion glaciated.
110. Seward Peninsula (47,000 km^2) (3, 6)	Maritime to continental. Ann. precip. 250 mm to 510 mm in the lowlands, >1,000 mm estimated for the mountains. Ann. snowfall 100 cm to 190 cm in the lowlands, probably up to 250 cm in the mountains. Avg. daily min. temp. in winter is –24°C to –19°C; avg. daily max. in summer is 13°C to 17°C.	Narrow strips of coastal lowlands, extensive uplands of broad convex hills and flat divides, small, isolated groups of rugged mountains. Elevations from sea level to 500 m for most of region, >1,400 m on high mountains. Slope gradients generally 0° to 5°, up to 15° typical in the mountains.	Paleozoic sediments and metamorphosed volcanic rocks and Precambrian volcanic rocks. Highlands may be Cenozoic uplifts of these formations. Extensive Quaternary or Tertiary volcanic rock formations in northeastern portion of ecoregion.	Continuously thin to moderately thick permafrost.	Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Typic Cryochrepts, Pergelic Cryumbrepts, Lithic Cryorthents, and Pergelic Cryorthents.	Mesic graminoid herbaceous communities and low scrub communities widespread on hills and lower mountains. Wet graminoid herbaceous communities in wettest areas. Tall scrub communities along drainages and on floodplains. Dwarf scrub communities in highlands.	Only highlands were glaciated.
111. Ahklun and Kilbuck Mountains (51,000 km^2) (2, 3, 6, 7)	Transitional. Ann. precip. 1,020 mm in lowlands to 2,030 mm in highlands. Ann. snowfall 205 cm in lowlands to 510 cm in highlands. Avg. daily min. temp. in winter is –16°C; avg. daily max. in summer is 16°C to 19°C.	Steep, rugged mountain groupings separated by broad lowlands. Elevations from sea level to >1,500 m. Slope gradients generally 0° to 8°, steeper slopes not uncommon.	Strongly deformed sedimentary and volcanic rocks of late Paleozoic and Mesozoic age. Small granitic masses surrounded by more resistant hornfels have formed ringlike mountain groups.	Discontinuous permafrost at higher elevations, isolated masses at lower elevations.	Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Typic Cryochrepts, Lithic Cryumbrepts, Pergelic Cryumbrepts, Pergelic Cryorthods, Typic Haplocryods, and Typic Humicryods.	Dwarf scrub communities in mountains. Mesic graminoid herbaceous communities on mesic valley sites. Wet graminoid herbaceous communities and low scrub herbaceous bogs on wettest valley sites. Needleleaf, broadleaf, and mixed forest stands on better drained valley sites.	Extensive.

Ecoregion	Climate (1)	Physiography (2)	Geology (3)	Permafrost (4)	Soils (5)	Vegetation (6)	Pleistocene Glaciation (7)
112. Bristol Bay–Nushagak Lowlands (61,000 km^2) (2, 3, 6, 7)	Transitional. Ann. precip. 330 mm to 860 mm. Ann. snowfall 75 cm to 250 cm. Avg. daily min. temp. in winter is –15°C to –10°C (higher in south, lower in north); avg. daily max. in summer is 18°C.	Rolling lowlands. Elevations from sea level to 150 m. Slope gradients generally 0– 2°.	Quaternary glacial outwash and morainal deposits, mantled in part by silt and peat.	Ranges from isolated masses of permafrost to areas free from permafrost.	Typic Haplocryands, Typic Vitricryands, Fluvaquentic Cryofibrists, Histic Pergelic Cryaquepts, Pergelic Cryaquepts, and Typic Cryochrepts.	Dwarf scrub communities most common on better drained sites. Low scrub bogs, wet graminoid herbaceous communities, and wet forb herbaceous communities on poorly drained sites. Broadleaf and mixed forest communities on floodplains of major rivers.	Extensive.
113. Alaska Peninsula Mountains (48,000 km^2) (2, 3, 4, 6, 7)	Maritime. Ann. precip. 600 mm to 3,300 mm in coastal lowlands, >4,060 mm at higher elevations. Ann. snowfall 55 cm to 150 cm in lowlands, >510 cm in mountains. Avg. daily min. temp. in winter is –11°C to –6°C; avg. daily max. in summer is ≈15°C.	Rounded ridges overtopped by steep, rugged mountains. Elevations from sea level to 2,600 m. Slope gradients generally 0° to 11°, steeper slopes not uncommon.	Stratified Jurassic, Cretaceous, and Tertiary sediments and undifferentiated Quaternary volcanic rocks.	Generally free from permafrost.	Typic Haplocryands and Typic Vitricryands.	Dwarf scrub communities at higher elevations and on windswept areas. Low scrub communities in more protected sites. Of less extensive distribution are tall scrub communities (in drainages and at low elevations), broadleaf forests (on floodplains and south–facing slopes), and low scrub bogs and mesic graminoid herbaceous communities (in poorly drained areas).	Extensive.
114. Aleutian Islands (12,000 km^2) (1, 3, 4, 6, 7)	Maritime. Ann. precip. 530 mm to 2,080 mm at sea level locations (smaller islands may have much less precip.). Ann. snowfall 85 cm to 250 cm at same locations. Avg. daily min. temp. in winter is –7°C to – 2°C; avg. daily max. in summer is 10°C to 13°C.	Low mountains, often overtopped by steep, rugged mountains. Elevations from sea level to >1,900 m. Slope gradients <1° in lowlands, >5° in mountains.	Blockfaulted Tertiary sediments surmounted by undifferentiated Quaternary and Tertiary volcanic rocks.	Generally free from permafrost.	Typic Haplocryands and Typic Vitricryands.	Dwarf scrub communities at higher elevations and on windswept areas. Mesic graminoid herbaceous communities and dry graminoid herbaceous communities at lower elevations and on sites protected from wind. Low scrub bogs in moist areas.	Only the easternmost portion glaciated.

Ecoregion	Climate (1)	Physiography (2)	Geology (3)	Permafrost (4)	Soils (5)	Vegetation (6)	Pleistocene Glaciation (7)
115. Cook Inlet ($28,000 km^2$) (1, 3, 4, 5, 6, 7)	Transitional. Ann. precip. 380 mm to 680 mm. Ann. snowfall 160 cm to 255 cm. Avg. daily min. temp. in winter is –15°C; avg. daily max. in summer is 18°C.	Level to rolling terrain. Elevations from sea level to 600 m. Slope gradients generally 0° to 3°.	Poorly consolidated Tertiary coal–bearing rocks mantled by glacial moraine and outwash, aeolian deposits, and marine and lake deposits.	Generally free from permafrost.	Haplocryands, Sphagnic Borofibrists, Terric Borosaprists, Typic Borohemists, Andic Haplocryods, and Andic Humicryods.	Needleleaf, broadleaf, and mixed forests widespread. Mesic graminoid, graminoid herbaceous, and low scrub graminoid communities in dry to mesic sites. Tall scrub communities on periodically flooded alluvium. Low scrub communities on poorly drained lowlands. Tall scrub swamps, low scrub bogs, wet forb herbaceous communities, and wet graminoid herbaceous communities on wettest sites.	Extensive.
116. Alaska Range ($117,000 km^2$) (1, 2, 3, 4, 6, 7)	Continental. Weather data available only for low elevations. Ann. precip. 380 mm at low elevations, probably ≈2,030 mm at high elevations. Ann. snowfall 150 cm to 305 cm at low elevations, probably ≈1,015 cm at high elevations. Avg. daily min. temp. in winter is –25°C at low elevations; avg. daily max. in summer is 18°C at same locations.	Steep, rugged mountains and broad valleys. Elevations from 600 m (sea level in southwest portion of ecoregion) to >3,900 m (Mt. McKinley >6,100 m). Slope gradients generally 5° to 25°, >25°on some mountains.	Southern portion underlain by granitic batholiths intrusive into moderately metamorphosed, highly deformed Paleozoic and Mesozoic volcanic and sedimentary rocks. This area includes active volcanoes. Central and eastern portions of ecoregion are a broad syncline having Cretaceous rocks in the center and Paleozoic and Precambrian rocks on the flanks. Rocky slopes, icefields, and glaciers cover much of region.	Discontinuous permafrost.	Lithic Cryorthents, Pergelic Cryaquepts, Pergelic Ruptic– Histic Cryaquepts, Typic Cryochrepts, Pergelic Cryumbrepts, and Typic Cryumbrepts.	Much of region is barren of vegetation. Dwarf scrub communities on drier, windswept sites. Low scrub communities and tall scrub communities on moist to mesic sites. Needleleaf forests and woodlands on well-drained sites of valleys and lower slopes.	Extensive.
117. Copper Plateau ($17,000 km^2$) (2, 3, 4, 5, 6, 7)	Continental. Ann. precip. 250 mm to 460 mm. Ann. snowfall 100 cm to 190 cm. Avg. daily min. temp. in winter is ≈–27°C; avg. daily max. in summer is ≈21°C.	Level to gently rolling plain. Elevations from 420 m to 900 m. Slope gradients generally 0° to 2°	Pleistocene proglacial lake deposits.	Thin to moderately thick permafrost.	Histic Pergelic Cryaquepts, Aquic Cryochrepts, Typic Cryochrepts, Pergelic Cryaquolls, and Typic Cryoborolls.	Needleleaf forests and woodlands predominate. Broadleaf forests, tall scrub communities, and needleleaf forests dominated by white spruce on better drained sites. Low scrub bogs and wet graminoid herbaceous communities in wettest areas.	Extensive.

Ecoregion	Climate (1)	Physiography (2)	Geology (3)	Permafrost (4)	Soils (5)	Vegetation (6)	Pleistocene Glaciation (7)
118. Wrangell Mountains (29,000 km^2) (1, 2, 3, 4, 6, 7)	Continental. Ann. precip. 410 mm at McCarthy (the only long–term weather station in the ecoregion), probably ≈2,030 mm at higher elevations. Ann. snowfall 175 cm at McCarthy, probably ≈255 cm at higher elevations. Avg. daily min. temp. in winter is –34°C at McCarthy; avg. daily max. in summer at same location is 22°C.	Steep, rugged mountains. Elevations from 600 m to >3,900 m. Slope gradients usually >7°, >15° for many areas.	Shield and composite volcanoes of Cenozoic age. Rocky slopes, icefields, and glaciers cover much of region.	Discontinuous permafrost.	Lithic Cryorthents, Typic Cryorthents, Pergelic Cryochrepts, and Pergelic Cryumbrepts.	Much of region is barren of vegetation. Dwarf scrub communities on drier, windswept sites. Tall scrub communities along drainages and on floodplains. Needleleaf and broadleaf forests at lower elevations on broad ridges, valleys, and hilly moraines.	Extensive.
119. Pacific Coastal Mountains (106,000 km^2) (1, 2, 3, 6, 7)	Transitional. No long–term weather data available. Ann. precip., interpolated from low elevation coastal station data, 2,030 mm to >7,000 mm. Ann. snowfall 510 cm to 2,030 cm. Ann. precip. generally increases with elevation.	Steep, rugged mountains. Elevations from sea level to >4,500 m. Slope gradients generally >7°, >20° on some mountains.	Cretaceous and Upper Jurassic sediments extensively throughout Chugach Mountains. Tertiary to Cretaceous (Paleozoic in some places) intrusive rock primarily throughout southeastern coastal mountains. Rocky slopes, icefields, and glaciers cover much of region.	Chugach Mountains have isolated masses of permafrost. The remainder of the ecoregion is generally free from permafrost.	Lithic Cryorthents, Andic Cryumbrepts, Pergelic Cryumbrepts, Typic Cryumbrepts, Typic Haplocryods, Andic Humicryods, Lithic Humicryods, and Typic Humicryods.	Much of region is barren of vegetation. Low and dwarf scrub communities are common where vegetation does occur. Needleleaf forests in some lower drainages.	Extensive.
120. Coastal Western Hemlock–Sitka Spruce Forests (61,000 km^2) (1, 4, 5, 6, 7)	Maritime. Ann. precip. 1,350 mm to 3,900 mm. Ann. snowfall 80 cm to 600 cm. Avg. daily min. temp. in winter is –3°C; avg. daily max. in summer is 18°C.	Level to irregular terrain to steep foothills of coastal mountains. Elevations from sea level to 500 m (includes some local mountains up to 1,000 m). Median slope gradient 5°, range is from 0° to 28°.	Lower Tertiary interbedded sedimentary, volcanogenic, and volcanic rocks in Prince William Sound area. Upper Cretaceous sandstone and slate on Kodiak Island. Mesozoic volcanic and intrusive rock, and Mesozoic and Paleozoic sediments in the southeastern portion of the ecoregion.	Generally free from permafrost.	Terric Cryohemists, Andic Cryaquods, Andic Humicryods, Lithic Humicryods, and Typic Humicryods.	Needleleaf, broadleaf, and mixed forests predominate. Tall scrub swamps, low scrub bogs, wet graminoid herbaceous communities, and wet forb herbaceous communities on wet sites.	Extensive.

The terrain roughness map was derived from 1–km^2 resolution digital elevation model (DEM) data using a raster based GIS. Procedures are listed below; common GIS terminology appears in italics.

1. The maximum change in local terrain elevation was calculated within a 5–km[a] radius around each pixel of the DEM data *(an 11x11 differencing filter was applied over the DEM raster map)*. This resulted in a new map where the original DEM data values were replaced by maximum elevation difference values. The maximum amount of local relief measured was 4,310 m.

2. Values on the maximum local relief map were then sorted *(sliced)* into consecutive classes so that each class represented a change in elevation of 10 m. This resulted in a map of 431 "relief change" classes.

3. The number of different relief change classes occurring within 25 km^2 around each pixel was used to calculate local terrain variability *(a 5x5 diversity filter was passed over the pixels of the relief change class map)*. The resultant map depicted values representing the number of different classes that occurred in the vicinity of each pixel. The maximum number of classes recorded for a single pixel was 25, which was also the theoretical maximum.

4. The values on the local terrain variability map were sorted *(reclassified)* into five classes of terrain roughness: very low (0–2 terrain change classes within the 5 km^2 vicinity of a pixel), low (3–5 change classes), moderate (6–10 change classes), high (11–15 change classes), and very high (16–25 change classes).

5. The average terrain roughness class within 25 km^2 of each pixel was determined *(a 5x5 low–pass, averaging filter was applied to the raster map of the five classes of local terrain roughness)*. This effectively smoothed the local "noise" on the map of terrain roughness classes so that broad–scale patterns of the variability in local relief were more discernible on the final terrain roughness map.

[a] Five kilometers was selected as an appropriate resolution for defining "local" relief based on the level of generalization represented by the ecoregions.

TREES[a]

Abies amabilis	Pacific silver fir
Abies lasiocarpa	Subalpine fir
Alnus rubra	Red alder
Betula papyrifera	Alaska paper birch
Larix laricina	Tamarack, larch
Picea glauca	White spruce
Picea mariana	Black spruce
Picea sitchensis	Sitka spruce
Pinus contorta	Lodgepole pine
Populus balsamifera	Balsam poplar
Populus tremuloides	Quaking aspen
Populus trichocarpa	Black cottonwood
Taxus brevifolia	Pacific yew
Tsuga heterophylla	Western hemlock
Tsuga mertensiana	Mountain hemlock

SHRUBS[b]

Alnus crispa	American green alder
Alnus sinuata	Sitka alder
Alnus tenuifolia	Thinleaf alder
Andromeda polifolia	Bog–rosemary
Arctostaphylos alpina	Alpine bearberry
Arctostaphylos rubra	Red–fruit bearberry
Arctostaphylos uva–ursi	Bearberry, kinnikinnik
Betula glandulosa	Resin birch, bog birch
Betula nana	Dwarf arctic birch
Cassiope lycopodioides	Alaska cassiope
Cassiope mertensiana	Mertens cassiope
Cassiope stelleriana	Starry cassiope
Cassiope tetragona	Four–angled cassiope
Chamaedaphne calyculata	Leatherleaf
Cladothamnus pyrolaeflorus	Copperbush
Cornus canadensis	Bunchberry, dwarf dogwood
Cornus stolonifera	Red–osier dogwood
Dryas drummondii	Drummond mountain–avens
Dryas integrifolia	Entire–leaf mountain–avens
Dryas octopetala	White mountain–avens
Empetrum nigrum	Crowberry
Kalmia polifolia	Bog kalmia
Ledum decumbens	Narrow–leaf Labrador–tea
Ledum groenlandicum	Labrador–tea
Loiseleuria procumbens	Alpine–azalea
Luetkea pectinata	Luetkea
Menziesia ferruginea	Rusty menziesia
Myrica gale	Sweetgale
Oplopanax horridus	Devilsclub
Phyllodoce aleutica	Blue mountain–heath
Potentilla fruticosa	Bush cinquefoil
Ribes triste	American red currant
Rosa acicularis	Prickly rose
Rubus spectabilis	Salmonberry
Salix alaxensis	Feltleaf willow
Salix arbusculoides	Littletree willow
Salix arctica	Arctic willow
Salix barclayi	Barclay willow
Salix bebbiana	Bebb willow
Salix brachycarpa	Barren–ground willow
Salix commutata	Undergreen willow
Salix fuscescens	Alaska bog willow
Salix glauca	Grayleaf willow
Salix lanata	Richardson willow
Salix ovalifolia	Ovalleaf willow
Salix phlebophylla	Skeletonleaf willow
Salix planifolia	Diamondleaf willow
Salix polaris	Polar willow
Salix reticulata	Netleaf willow
Salix rotundifolia	Least willow
Salix scouleriana	Scouler willow
Salix sitchensis	Sitka willow
Sambucus callicarpa	Pacific red elder
Shepherdia canadensis	Buffaloberry
Spiraea beauverdiana	Beauverd spirea
Vaccinium alaskaense	Alaska blueberry
Vaccinium caespitosum	Dwarf blueberry
Vaccinium ovalifolium	Early blueberry
Vaccinium oxycoccos	Bog cranberry
Vaccinium parvifolium	Red huckleberry
Vaccinium uliginosum	Bog blueberry
Vaccinium vitis–idaea	Mountain–cranberry
Viburnum edule	High bushcranberry

[a] Nomenclature from Viereck and Little (1972), as cited in Viereck and others (1992).

[b] Nomenclature from Hultén (1968) and Welsh (1974), as cited in Viereck and others (1992).

HERBS[c]

Aconitum delphinifolium	Monkshood
Agropyron spicatum	Bluebunch wheatgrass
Alopecurus alpinus	Alpine foxtail
Anemone spp.	Anemone
Angelica lucida	Sea coast angelica
Arctagrostis latifolia	Polar grass
Arctophila fulva	Pendent grass
Artemisia arctica	Wormwood
Astragalus spp.	Milk vetch
Athyrium filix–femina	Lady fern
Blechnum spicant	Deer fern
Bromus pumpellianus	Brome grass
Calamagrostis canadensis	Bluejoint
Calamagrostis purpurascens	Purple reed–grass
Caltha palustris	Yellow marsh–marigold
Carex aquatilis	Water sedge
Carex bigelowii	Bigelow sedge
Carex lyngbyaei	Lyngbye sedge
Carex misandra	Short–leaved sedge
Carex pauciflora	Few–flowered sedge
Carex pluriflora	Many–flowered sedge
Carex rostrata	Beaked sedge
Carex saxatilis	No common name
Carex scirpoidea	Northern single–spike sedge
Carex sitchensis	Sitka sedge
Coptis aspleniifolia	Goldthread
Deschampsia beringensis	Bering hair–grass
Dryopteris dilatata	Spinulose shield–fern
Dupontia fischeri	Tundra grass, dupontia
Eleocharis palustrus	Spike rush
Epilobium angustifolium	Fireweed
Epilobium latifolium	Dwarf fireweed
Equisetum arvense	Meadow horsetail
Equisetum fluviatile	Swamp horsetail
Equisetum sylvaticum	Woodland horsetail
Equisetum variegatum	Variegated scouring-rush
Eriophorum angustifolium	Tall cottongrass
Eriophorum russeolum	Russett cottongrass
Eriophorum vaginatum	Tussock cottongrass
Fauria crista–galli	Deer cabbage
Festuca altaica	Fescue grass
Festuca rubra	Red fescue
Galium boreale	Northern bedstraw
Geranium erianthum	Northern geranium
Gymnocarpium dryopteris	Oak fern
Hedysarum alpinum	Alpine sweet–vetch
Heracleum lanatum	Cow parsnip
Hierochloë alpina	Alpine holygrass
Honckenya peploides	Seabeach sandwort
Juncus arcticus	Arctic rush
Kobresia myosuroides	No common name
Linnaea borealis	Twinflower
Lupinus nootkatensis	Nootka lupine
Maianthemum dilatatum	False lily–of–the–valley
Menyanthes trifoliata	Buckbean
Mertensia paniculata	Bluebell
Minuartia spp.	Sandwort
Oxytropis nigrescens	Blackish oxytrope
Petasites frigidus	Arctic sweet coltsfoot
Plantago maritima	Goose–tongue
Poa eminens	Coastal bluegrass
Potentilla palustris	Marsh fivefinger
Puccinellia spp.	Alkali grass
Pyrola grandiflora	Large–flowered wintergreen
Rubus pedatus	Five–leaf bramble
Saxifraga spp.	Saxifrage
Scirpus validus	Great bulrush
Sedum rosea	Roseroot
Streptopus spp.	Twisted–stalk
Tiarella trifoliata	Lace flower
Trichophorum caespitosum	Tufted clubrush
Triglochin maritimum	Maritime arrow grass
Valeriana sitchensis	Sitka valerian

[c] Nomenclature from Viereck and Little (1972), as cited in Viereck and others (1992).

MOSSES[d]			
Aulacomnium palustre	No common name	*Pleurozium schreberi*	Feathermoss
Campylium stellatum	No common name	*Polytrichum spp.*	No common name
Dicranum spp.	No common name	*Rhacomitrium lanuginosum*	No common name
Distichium capillaceum	No common name	*Rhytidiadelphus triquetrus*	No common name
Drepanocladus uncinatus	No common name	*Rhytidium rugosum*	No common name
Hylocomium splendens	Feathermoss	*Scorpidium spp.*	No common name
Hypnum spp.	No common name	*Sphagnum spp.*	Sphagnum moss
Mnium spp.	No common name	*Tomenthypnum nitens*	No common name
LICHENS[e]			
Alectoria spp.	No common name	*Parmelia spp.*	No common name
Cetraria cucullata	No common name	*Peltigera aphthosa*	No common name
Cetraria islandica	No common name	*Peltigera canina*	Dog lichen
Cladina rangiferina	Reindeer lichen	*Stereocaulon tomentosum*	No common name
Cladonia spp.	No common name	*Thamnolia subuliformis*	No common name
Nephroma arcticum	No common name	*Thamnolia vermicularis*	Worm lichen

[d] Nomenclature from Crum and others (1973), as cited in Viereck and others (1992).

[e] Nomenclature from Egan (1987), as cited in Viereck and others (1992).